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# Planning a Machine Tool Shop for Systematized Manufacture

**Principles Involved in the Building of a Plant for the Manufacture of Machine Tools to Insure Systematized Procedure and Efficiency in Production—Based upon the Ideas Embodied in the New Plant of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio**

BY ERIK OBERG

THE city of Cincinnati is the leading machine tool center of the United States, as regards the number of manufacturers, the number of large plants, the variety of machine tools built, and the number of modern plants that have recently been erected. One of the latest additions to these modern machine tool plants is that of the R. K. LeBlond Machine Tool Co., located in the Hyde Park district of Cincinnati, close to the Norfolk & Western Railway and within a few minutes' walk of three car lines, two of which pass directly by the plant. This plant embodies the most modern ideas in shop construction, and has been planned with a view to making it possible to pass the work through the shop without unnecessary trucking or transportation, the raw material entering at one end and the finished product passing out at the other.

As shown in the plan view in Fig. 4, the plant consists of a one-story sawtooth roof building, the extreme width of which is 350 feet, and the extreme length, 725 feet. In addition, there is a four-story administration building, 75 by 300 feet. The one-story shop is divided into a manufacturing building, 250 by 640 feet, in which the bays run crosswise, and two high erecting departments in which the bays run lengthwise, covering an area of 100 by 725 feet. As indicated in Fig. 4, ample railroad facilities are provided, two tracks entering the building at the rear and one track passing along the shipping platform near the front end of the erecting bays, where the machines are boxed.

**During recent years, a new idea has been embodied in the building of plants for the manufacture of machinery in general, and especially in shops for the making of machine tools. Briefly stated, this idea embodies the principle of passing the work through the shop as nearly as possible in one continuous line or circuit, from the point where the raw materials enter to the erecting space and shipping department. This idea is exemplified in the new plant of the R. K. LeBlond Machine Tool Co., one of the largest machine tool shops in the world under a single roof. This plant has been laid out with the definite view of making possible the systematic and efficient manufacture of heavy lathes and milling machines.**

### Receiving and Storing Raw Materials

The raw materials, both castings and bar stock, enter the shop at the rear end, which is shown to the left in Fig. 4. Most of the material is delivered by railroad cars from tracks that pass into the plant, so that all unloading may be done under roof, but provisions are also made for truck or wagon deliveries, by means of large doors and broad aisles near the storage space for bar steel and castings. As indicated in the plan of the shop, cranes are provided over these receiving aisles as well as in the bay next to the receiving railroad track.

While the R. K. LeBlond Machine Tool Co. does not operate its own foundry, all the castings are made in local foundries, and there is, therefore, an opportunity to have them made under the supervision of the company's own metallurgist. All the smaller castings are roughly inspected at the foundry before being shipped to the LeBlond plant, and upon arrival in the plant, they are first put through a Pangborn sand blast (located near the receiving platform as shown in the plan) for cleaning and are then weighed, the scale being placed beneath a traveling crane, making the handling of heavy castings convenient. Chippers' benches are placed behind the sand-blasting outfit for chipping castings before they go into the storage. After sand-blasting, the smaller castings are given a final inspection, but the heavier castings are completely inspected at the foundry to prevent unnecessary transportation. All of the castings are stored under roof,

Fig. 1. Bird's-eye View of the R. K. LeBlond Machine Tool Co.'s New Plant in Cincinnati, Ohio

the smaller castings in an elaborate system of steel bins, part of which is shown in Fig. 2, and the larger castings on the floor in orderly and systematically arranged piles, special places being provided for different classes of castings, and proper care being taken so that the trucking aisles are left free and open. A recording system is provided and is in charge of the casting stock-keeper so that a perpetual inventory is available showing how many castings are in stock. All the aisles and the bins in the small castings storage-bin system are properly numbered, and by reference to the records any casting can be located instantly.

There are altogether 65 aisles and 799 sections in the cast-iron storage racks, which are made from standard steel shelving. In front of the storage bins, an elevator is placed leading up from the basement beneath part of the shop which is used as storage for rough castings when there is an overflow of materials. The storage bin for the small castings occupies a space of approximately 35 by 135 feet. The bins are arranged in two stories with a balcony around the upper tier, as indicated, each story being four or five bins high. Each bin is marked with the same piece number as is used on the drawings so that the parts are easily identified.

The duties of the stock-keeper in charge of the castings consist of receiving the castings, counting and weighing them, and reporting accepted shipments to the purchasing department for payment. He also keeps the perpetual inventory mentioned, and notifies the planning department when new castings must be ordered, so as to keep a sufficient balance of stock on hand at all times.

### Steel Storage Department

The bar stock is received and stored in a separate department and is in the charge of a foreman who also has charge of the cutting-off machines. Steel racks of heavy construction are used for storing the bar stock, as shown in Fig. 3. There are, in all, 265 compartments in these racks, making it possible to properly segregate and store the different kinds and sizes of steel used. Very heavy bar stock is stored on the floor in a space at the end of the racks. The hacksaws, cutting-off machines, and centering machines are placed directly in front of the steel storage racks. The foreman of this department receives all bar stock that comes into the plant and reports the receipt to the purchasing department. He also reports to the purchasing department the amount of stock that leaves his storage racks for the different manufacturing departments, so that new orders can be placed for stock of any size or quality as it runs low.

The material from both the casting storage department and the steel storage racks is requisitioned from these departments by the head of the production department, and routed through the shop according to definite instructions as laid down by the planning department.

The cut-off stock from the cutting-off department is placed on so-called "tote boxes" which are constructed in many different ways, according to the material to be carried, and arranged to fit the Stuebing elevating truck. Fig. 5 shows one of these tote boxes provided with storage racks especially fitted for carrying cut-off bar stock, shafts, and similar parts. Fig. 6 shows simple platforms, as well as a tote box with shelves, and ordinary simple tote boxes for carrying castings or forgings from department to department. The boxes to the left, shown piled one on top of another, indicate how this system lends itself to the building up of units, much in the same way as sectional bookcases are built up.

### The Manufacturing Departments

The manufacturing departments are so arranged that the rough stock from the storage racks and bins will pass from department to department in the most direct manner possible. Heavy castings, for example, will first pass to the planing department, the crane lay-out being such that there is the least possible amount of lost motion. They then will pass to the drilling department, the boring machines, or other departments, as required. The crane service is so arranged that the cranes over the manufacturing departments, which are indicated by heavy black lines in Fig. 4, can move partly into the high erecting bay where their load may be picked up by the large cranes that move lengthwise

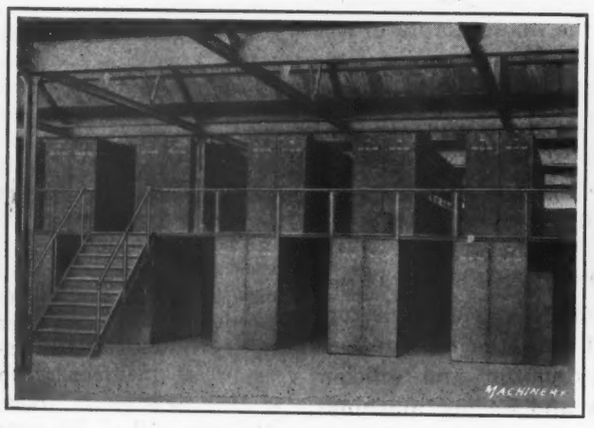


Fig. 2. Storage Racks for Small Castings

Fig. 3. Storage Racks for Bar Stock

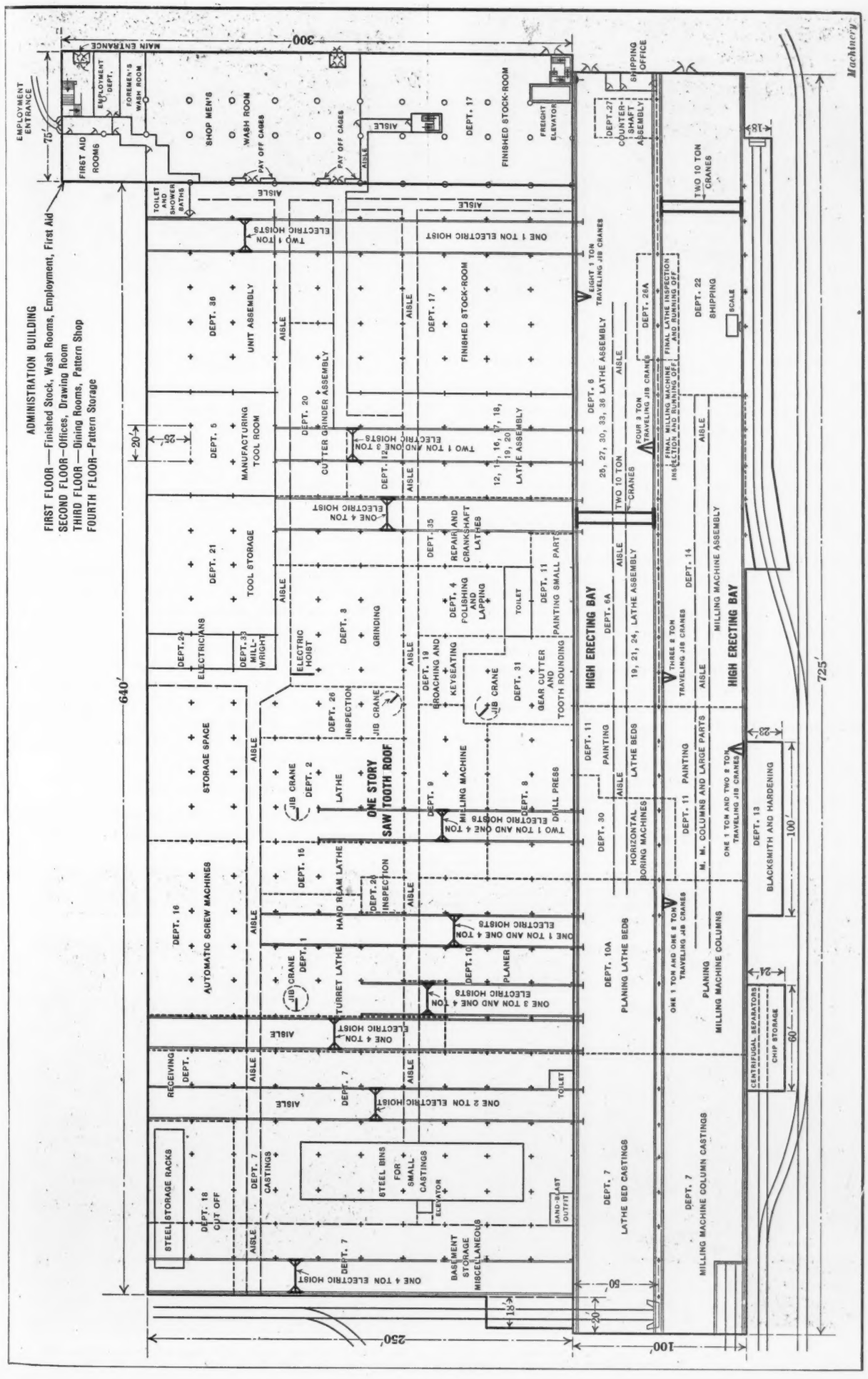
ADMINISTRATION BUILDING
FIRST FLOOR—Finished Stock, Wash Rooms, Employment, First Aid
SECOND FLOOR—Offices, Drawing Room
THIRD FLOOR—Dining Rooms, Pattern Shop
FOURTH FLOOR—Pattern Storage
Machinery
MAIN ENTRANCE
EMPLOYMENT ENTRANCE
EMPLOYMENT DEPT.
FOREMEN'S WASH ROOM
FIRST AID ROOMS
SHOP MEN'S
WASH ROOM
PAY OFF CAGES
DEPT. 17
FINISHED STOCK-ROOM
FREIGHT ELEVATOR
SHIPPING OFFICE
DEPT. 27 COUNTER-SHAFT ASSEMBLY
TOILET AND SHOWER BATHS
ONE 1 TON ELECTRIC HOIST
TWO 1 TON ELECTRIC HOISTS
DEPT. 36 UNIT ASSEMBLY
DEPT. 5 MANUFACTURING TOOL ROOM
DEPT. 20 CUTTER GRINDER ASSEMBLY
DEPT. 12
TWO 1 TON AND ONE 3 TON ELECTRIC HOISTS
DEPT. 17 FINISHED STOCK-ROOM
EIGHT 1 TON TRAVELING JIB CRANES
DEPT. 6 25, 27, 30, 33, 36 LATHE ASSEMBLY
DEPT. 26A FINAL MILLING MACHINE INSPECTION AND RUNNING OFF
FINAL LATHE INSPECTION AND RUNNING OFF
DEPT. 22 SHIPPING
SCALE
TWO 10 TON CRANES
FOUR 3 TON TRAVELING JIB CRANES
ONE 4 TON ELECTRIC HOIST
DEPT. 21 TOOL STORAGE
DEPT. 35 REPAIR AND CRANK SHAFT LATHES
DEPT. 4 POLISHING AND LAPPING
TOILET
DEPT. 11 PAINTING SMALL PARTS
DEPT. 24 ELECTRICIANS
DEPT. 33 MILL-WRIGHT
ELECTRIC HOIST
DEPT. 8 GRINDING
DEPT. 18 BROACHING AND KEYSEATING
JIB CRANE
DEPT. 31 GEAR CUTTER AND TOOTH ROUNDING
HIGH ERECTING BAY
DEPT. 6A 19, 21, 24, LATHE ASSEMBLY
THREE 5 TON TRAVELING JIB CRANES
DEPT. 14 MILLING MACHINE ASSEMBLY
ONE 1 TON AND TWO 5 TON TRAVELING JIB CRANES
DEPT. 26 INSPECTION
DEPT. 2 LATHE
ONE STORY SAW TOOTH ROOF
DEPT. 9 MILLING MACHINE
DEPT. 8 DRILL PRESS
TWO 1 TON AND ONE 4 TON ELECTRIC HOISTS
DEPT. 11 PAINTING
DEPT. 30 HORIZONTAL BORING MACHINES
LATHE BEDS
DEPT. 16 AUTOMATIC SCREW MACHINES
STORAGE SPACE
DEPT. 15 HARD REAM LATHE
DEPT. 28 INSPECTION
DEPT. 1 TURRET LATHE
DEPT. 10 PLANER
ONE 1 TON AND ONE 4 TON ELECTRIC HOISTS
ONE 3 TON AND ONE 4 TON ELECTRIC HOISTS
DEPT. 10A PLANING LATHE BEDS
ONE 1 TON AND ONE 5 TON TRAVELING JIB CRANES
DEPT. 11 PAINTING
M. M. COLUMNS AND LARGE PARTS
PLANING MILLING MACHINE COLUMNS
ONE 4 TON ELECTRIC HOIST
RECEIVING DEPT.
DEPT. 7 CASTINGS
ONE 2 TON ELECTRIC HOIST
TOILET
DEPT. 13 BLACKSMITH AND HARDENING
CENTRIFUGAL SEPARATORS
CHIP STORAGE
STEEL STORAGE RACKS
DEPT. 18 CUT OFF
STEEL BINS FOR SMALL CASTINGS
ELEVATOR
SAND-BLAST OUTFIT
DEPT. 7 LATHE BED CASTINGS
DEPT. 7 MILLING MACHINE COLUMN CASTINGS
BASEMENT STORAGE MISCELLANEOUS
ONE 4 TON ELECTRIC HOIST
AISLE
300'
640'
725'
250'
100'

Fig. 4. Plan of the R. K. LeBlond Machine Tool Co.'s New Plant

Fig. 5. Tote Boxes with Special Racks used for transporting Bar Stock in the Plant

Fig. 6. Tote Boxes and Trucks used for moving Parts from Department to Department

of these bays. A study of the lay-out of the shop as shown in Fig. 4 will far more effectively indicate how the principle of the progressive movement of the work has been applied than could any lengthy description.

After the machining operations have been performed on the heavy castings, they pass to the painting department where they are "filled" and then given a first coat of paint, after which, in the case of lathe beds, they are passed on to the assembling floor, the legs put on, and the planed surfaces hand-polished, cross-scraped, and spotted. After this, the beds are ready to be assembled with their units—that is, headstocks, footstocks, gear-boxes, etc.—the final coat of paint being given to the machines just before they are shipped.

The smaller castings go to the chucking department where they are rough-turned, bored, etc., passing from there to the grinding, milling, or drilling department, as occasion requires. All of these departments are so arranged with reference to each other as to facilitate the direct movement of the parts through the shop.

Fig. 7 shows a general view of the manufacturing departments, and also indicates the long wide aisles that are provided for trucking from department to department. All the posts are numbered, as indicated, in the lengthwise direction of the shop. The aisles are similarly lettered in a crosswise direction, so that by indicating the letter and the number, any section of the shop can be instantly located, much in the same way as a block in a city is located by giving the number of the street and the avenue, in cases where numbered streets are used. Lines are painted with bright colors on the floor to indicate the space set aside for aisles. No material may be stored inside of these lines, nor may any machinery or equipment project into the aisle space designated by the lines.

### The Inspection Department

A main inspection department is centrally located between the lathe and grinding departments, and, in addition, there are a number of small inspection divisions between the various manufacturing sections so that, in cases where the bringing of all the parts to the central inspection department after each operation would require too much trucking, and would break up the direct routing of the parts through the shop, the inspection may be made near the point where the work is performed. The large pieces are inspected at the machine where they are operated upon, all work being inspected after every important operation.

### The Trucking Department

All the moving of the parts from the raw material stockroom, from department to department, and to and from the

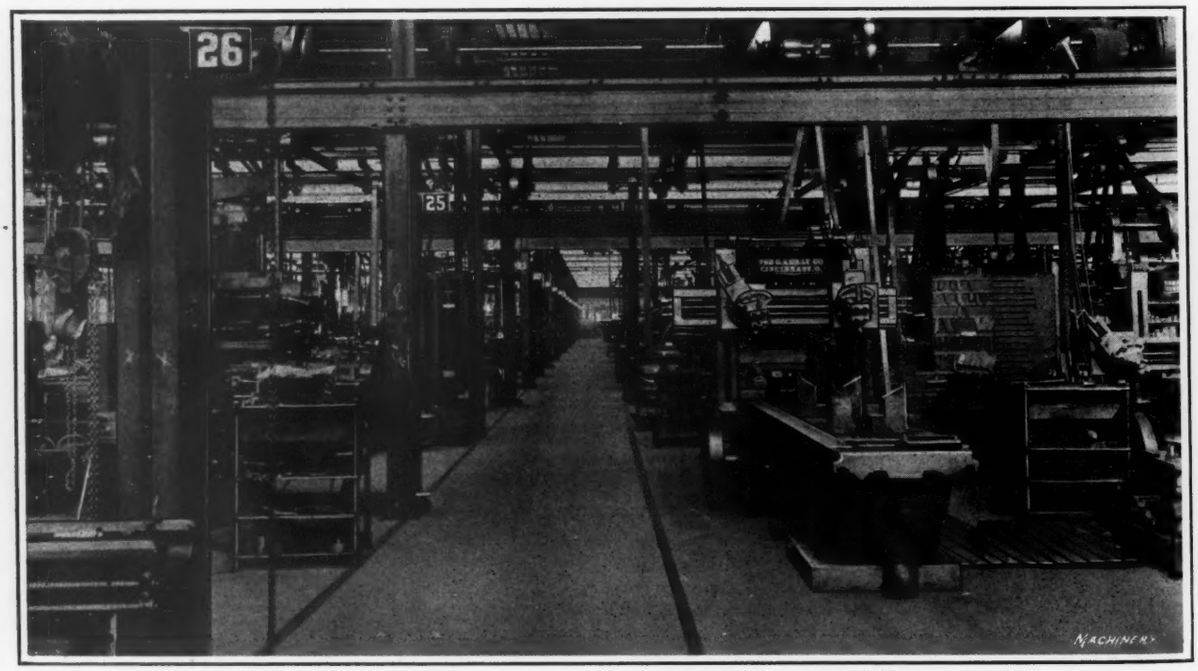


Fig. 7. One of the Aisles in the LeBlond Plant, showing Lines painted on the Floor to indicate Space which must not be obstructed, and Numbers on Posts which make it Possible to locate definitely Any Place in the Shop

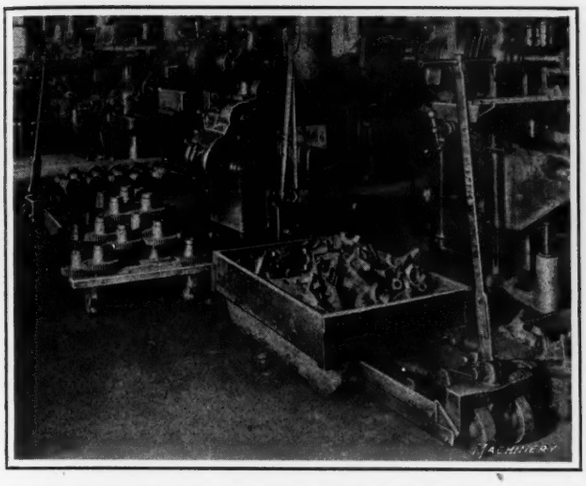

Fig. 8. Finished Work kept in Tote Boxes Ready to be delivered to the Stock-room

Fig. 9. Methods of loading Finished Work on Standard Tote Boxes for Transportation within the Shop

finished stock-room, is taken care of by a central trucking department which is in the charge of a foreman whose duty it is to see that all parts are moved from operation to operation in ample time to meet the requirements of the department that is to perform the next operation. The foreman of the trucking department obtains his instructions automatically by the routing system that is employed. Two classes of trucks are used. For heavy work, electric trucks, made by the Automatic Transportation Co., Buffalo, N. Y., are employed, and for lighter work, the Stuebing hand trucks already referred to are used. All trucks are of the elevating type, so that they can be used in connection with interchangeable tote boxes. Figs. 8 and 9 show finished work ready to be trucked to the finished store-room, to which all small parts pass before they are issued to the assembling departments. The numbering and lettering of the aisles and bays makes it very easy for the truckmen to bring the tote boxes from any designated point in the shop and deliver the parts to the exact location where they are wanted.

### The Finished Stock-room

Fig. 10 shows a view in the finished stock-room in which all work is stored and classified according to lot numbers and piece numbers, and in which all the finished material is kept until called for by the unit assembling department which assembles all units for the machines, such as headstocks, gear-boxes, feed-boxes, etc. As indicated in Fig. 4, the finished stock-room occupies a space of approximately 200 by 140 feet, and consists of an open space as shown in Fig. 10, together with a space occupied by steel shelving, on the mezzanine floor of which are stored supplies and materials of various kinds. This is the complete storage department for finished products for the whole shop, whether these products be parts completed in the shop itself or finished materials of various kinds bought from the outside.

### The Unit Assembling Department

When certain units are to be assembled, an order is sent by the foreman of the unit assembling department to the finished stock-room, calling for the parts required for the units. These parts are then collected and loaded upon tote boxes having shelves as indicated in Fig. 11, and are trucked to the unit assembling department which is located directly outside of the finished stock-room, as may be seen by reference to Fig. 4. This method greatly simplifies the work of the assemblers, because all the parts required by them for a given lot of units are kept together until the assembly is completed. The unit assembling department, a view of which is shown in Fig. 13, is instructed by the planning

Fig. 10. The Stock-room for Finished Materials and Supplies

Fig. 11. Tote Boxes provided with Shelves for sending Parts from Finished Stock-room to Unit Assembling Department

department when to start to assemble any specific lot of units. When the assembling is completed, the unit is inspected and is given a trial run. When approved, the unit is returned to the stock-room, use still being made of the standard tote boxes, as indicated in Fig. 12. In fact, these tote boxes are one of the institutions of the LeBlond plant, and are considered as one of the most important means toward efficiency, as they save a great amount of unnecessary handling of parts or assembled units, and make it possible to move any material easily and quickly from one part of the plant to another.

### Machine Assembling Departments

The machine assembling departments are located in the high erecting bays running beside the manufacturing part of the plant. There are two of these bays, each 50 feet wide by 725 feet long, and each served by two 10-ton cranes. In addition to these large cranes, the erecting bays are also provided with a number of smaller traveling jib cranes, which may be moved along the sides of the bays and which pass beneath the large traveling cranes. This arrangement makes it possible to use a smaller crane for the lighter work, leaving the heavy traveling ones for the heavier work. One of the erecting bays is devoted to the assembling of lathes, and the other to the assembling of milling machines, a view in the former being shown in Fig. 14.

The assembling departments which are already in possession of the beds or columns not passed to the finished stock-room, call upon the stock-room for the particular units required for completing the assembling of the machines. These units are delivered to them according to the routing system in ample time for the assembly of the machines to be completed for shipment. Even in the assembling work, the tote box principle is carried out in great detail. As shown in Fig. 15, a frame is built provided with rollers for supporting a milling machine table, while scraping and fitting. This frame is so constructed that it may be moved from point to point by the use of the standard elevating truck. The smaller machines being assembled are also placed on tote boxes while being worked upon, and a platform provided around them for the workmen, as indicated in Fig. 16, making it easy to move the whole machine from point to point. In

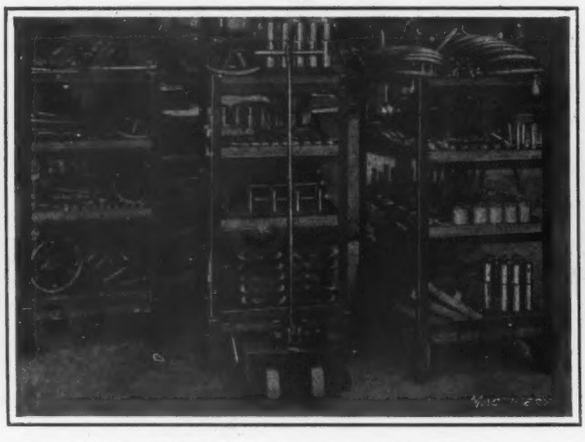

Fig. 12. Tote Boxes used for returning Assembled Units from Unit Assembling Department to Finished Stock-room

Fig. 13. Department for assembling Units such as Headstocks, Gear-boxes, etc.

Fig. 14. General View in Lathe Assembling Department

the illustration shown, the machine is in position for a running test.

### Shipping Facilities

When the machines are assembled, the cranes move them to the shipping department where five railroad cars may be loaded at a time directly from the shipping platform inside the building. The runways of the crane in the outside bay, however, also extend into the yard outside the building, and there pass over railroad tracks, so that cars may be loaded outside the shop also, in case of necessity.

### The Tool-room

It is evident that a plant of the size described would require a large, well-equipped tool-room. This tool-room is located to the left of the unit assembling department and next to it is placed the tool storage racks from which tools required in the plant are drawn by the different departments. A view in the tool-room is shown in Fig. 17. The tool-room occupies a space of 60 by 80 feet, and the tool storage, a space of 80 by 80 feet.

Throughout the whole shop there are no walls or partitions except around the finished stock-room, which is provided with a wire netting partition, and around the tool-room and tool storage departments, which have a partition about 3 feet high.

### Special Features about the LeBlond Plant

In addition to the main departments referred to, there are a number of minor departments provided with many special features of interest. As an example may be mentioned the paint shop for small parts, a view of which is shown in Fig. 18. Here an exhaust system is provided so that all the paint fumes are removed by suction. As indicated in the illustration, a grating is provided upon which the painter performs his work. Underneath this grating are holes connecting with a suction pipe which, in turn, connects with a main at the end of which is placed a large fan for the exhaust. Grinding wheels for polishing or grinding parts preparatory to painting are also placed on this bench near the exhaust. In this way, the air is kept free from both dust and fumes, and the health of the workers is effectively safeguarded.

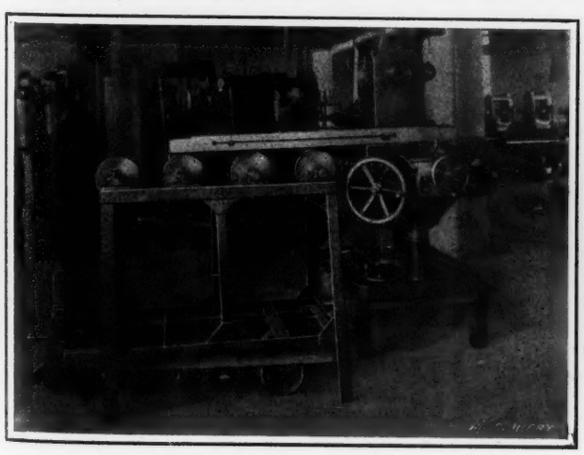

Fig. 15. Using Portable Appliances in the Assembly of Milling Machines

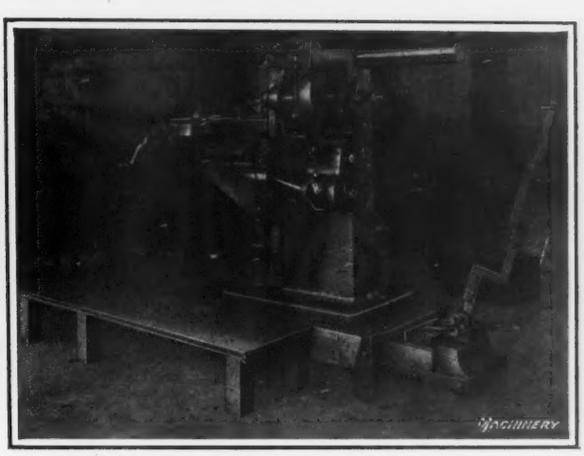

Fig. 16. The Use of Standard Tote Boxes and Trucks for moving Assembled Machines

Fig. 17. A View in the Tool-room of the LeBlond Plant

The chips are collected from the machines at certain stations through the shop and are classified according to material—whether steel, brass, or cast iron. They are then taken by the cranes in large buckets to an elevator which leads to the chip storage building just outside the high erecting bay. Here centrifugal separators free the chips from oil, and they are then let down through chutes into railway cars that are run along tracks beneath the chip storage building. By classifying the chips and properly separating them from the oil, a higher price is obtained for them, and at the same time the oil is recovered. On the outside of the high erecting bays is also provided a modern hardening room with pyrometer control and a blacksmith shop.

The lighting of the plant is of the best, as would be inferred from the construction. At night, the lighting is also very good, as the shop has Cooper-Hewitt lights placed at such a height as to provide a soft and well-diffused light. As an indication of the excellence of this light, Fig. 20 is shown, which was taken in the shop at night with no other light than that furnished by the Cooper-Hewitt tubes.

### The Administration Building

The administration building contains on the second floor the general offices, the drawing-room, and the planning and routing department. The first floor is devoted partly to the finished stock-room, the wash-rooms, locker-rooms, employment office, and first-aid rooms, a complete shop hospital being provided. On the third floor are the pattern shop and the dining-room for the employes, while the fourth floor is used for pattern storage and also for the storage of finished machines. A view of this floor is shown in Fig. 19, and this indicates, in a general way, the type of reinforced concrete construction that is used for the administration building.

In front of the administration building a large semicircular concrete garage is provided which is divided into thirty individual garages having a capacity for thirty-five cars. These are heated and provided with running water and a gasoline and oil vending system, as well as with compressed air. These garages are rented to employes at the rate of $2 a month.

The third floor of the administration building is devoted to a lunch room where meals are served at cost, so that the men may obtain a complete meal for 25 cents. There are also self-service counters for those who might want a lighter lunch. The charge made by the company provides only for the cost of labor and supplies, while light, heat, and floor space are supplied free. A band of about twenty men, made up entirely of shopmen, plays during the lunch hour in the lunch room twice a week, and twice a week motion pictures

Fig. 18. Paint Shop provided with Means for exhausting Dust and Fumes

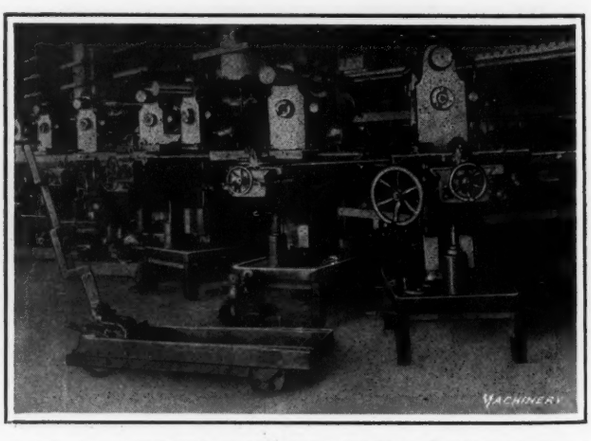

Fig. 19. View showing a Section of the Milling Machine Storage Department

of an educational as well as an entertaining character are shown. The tables and the equipment of the lunch room may be easily removed and the room used as an auditorium for lectures or for other entertainment purposes. A feature that has proved of great advantage in connection with the restaurant service is that it is run by a man who is hired and paid a salary by the company, instead of being contracted for by outside interests. In this way more satisfactory service is obtained.

In subsequent articles various systems and methods used in the R. K. LeBlond Machine Tool Co.'s plant will be dealt with, including the time study, rate-setting and bonus system; interesting special machines and methods developed and used in the plant; the planning and routing system; and the methods employed for increasing the efficiency of the men in the plant, including medical care and welfare work. This phase of the management of a machine shop has been highly developed at the LeBlond plant, the principle that it is good business to take care of the working organization's health and welfare being fully appreciated.

Fig. 20. Assembling Department at Night, showing the Excellent Artificial Light installed in the Plant

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## STEEL WHEEL FOR AUTOMOBILES

A Philadelphia manufacturer is producing a steel wheel for automobiles that looks very much the same as a wooden wheel, according to the *Scientific American*. It is of a built-up construction, but is simpler than the usual forms because there are but few welds and these are easy to make. It is believed that a wheel of this nature can be made as light as a wooden wheel of the same size and be very much stronger and not subject to deterioration or damage as the wheel of less resisting material would be. Each of the shanks or wedge ends of the spokes are steel castings, but these could be drop-forgings, and it is possible to make them either individually or to cast or forge the whole set in one integral portion. The tubular steel spokes are welded in place, and the nipple at the upper end which secures the felloe is afterward peened over so as to hold the rim absolutely. The felloe is of a rectangular box section and the tire-carrying rim is, of course, fitted outside this. As the wheel looks exactly like a wooden one, the motorist of conservative tastes cannot object to it because it is unconventional in appearance.

## CHARACTERISTICS OF CHROMIUM-NICKEL STEEL

Chromium-nickel steels have one outstanding characteristic, and that is their great resistance to any form of physical change. This is evident from the melting and pouring of the metal into ingots, through the rolling, forging, heat-treatment, machining, and use. This characteristic is responsible for the extremely high physical properties obtainable with chromium-nickel steel and is the cause of a great deal of trouble with the handling and treatment of this class of steel. Great care is required in refining the steel in order to secure clean metal; it requires extra pains with teeming, with the handling of the ingots and so on. It is difficult to forge or roll, especially as it will not weld and is likely to develop laps, seams, and cold shuts. The range of rolling temperature is narrow, and great care must be taken to see that it is not exceeded and that rolling is stopped before the stock cools too far. The same thing is true of forging, which should not be done at a temperature of over 2000 degrees F., and care must be exercised during the forging operation to avoid causing any laps, seams, or cold shuts.

It is comparatively difficult to machine chromium-nickel steel. It cannot be cut at extremely high speeds; in order to obtain rapid production the speed of the tool must be reduced, although the feed can be somewhat increased. Chromium-vanadium will machine at a Brinell hardness of 321 as freely as chromium-nickel of the same carbon content at a Brinell hardness of 241. In a milling or profiling operation, where the cutting speed on chromium-vanadium is approximately 120 feet per minute, the speed must be reduced to 85 feet per minute on chromium-nickel. If the speed is maintained at a high rate, the material glazes or burnishes, the tool skates, becomes heated, and goes to pieces.

* * *

The total merchant tonnage of the world prior to the outbreak of the war was about 50,000,000 tons, 15,000,000 tons of which were destroyed by submarines. The total amount of new shipping constructed during that period amounted to about 11,000,000 tons, leaving a shortage of 4,000,000. If the present program is carried out, the United States will have, in less than two years, approximately 2000 ships averaging 10,000 tons displacement.

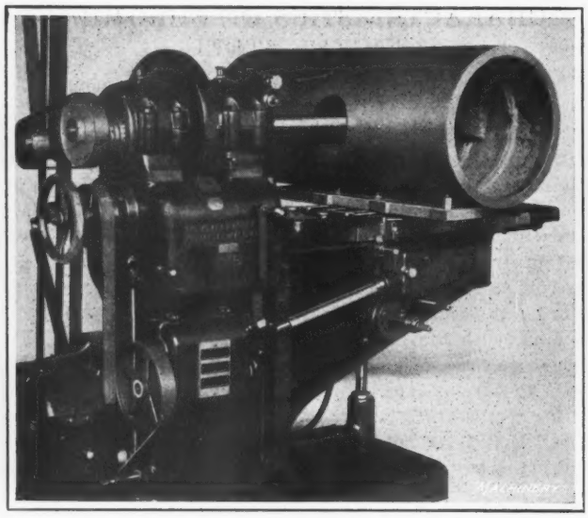

Fig. 1. Grinding Wrist-pin Hole in a Large Diesel Engine Piston

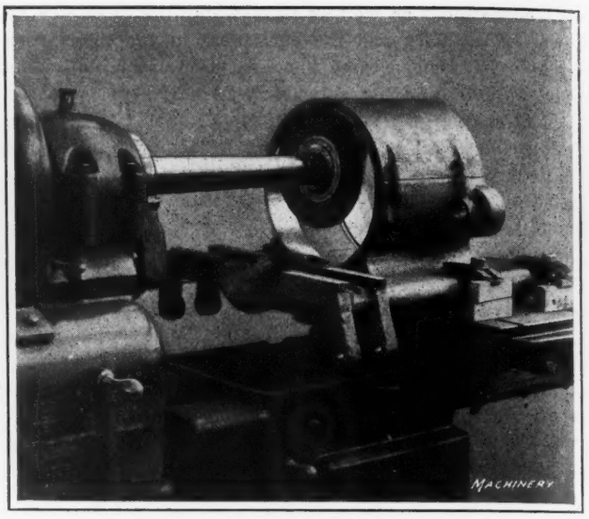


Fig. 2. Grinding 12-inch Hole in a Casting of Irregular Shape

# Cylinder Grinding Applied to Special Work

THE eccentric head or planetary type of grinding machine, which is used so extensively for grinding the cylinders of gas and gasoline engines, may be used to advantage for many other internal grinding operations. This type of machine is particularly adapted for grinding holes in parts which are either too large to be revolved or are so shaped that a rotary motion would be impracticable. For instance, if the hole to be ground is located considerably off center, or if the work is not symmetrical in shape, careful balancing is necessary, and frequently it is quite difficult to hold or clamp such work when it must be revolved rapidly for the grinding operation.

One example of internal grinding, for which a cylinder grinding machine proved effective, is shown in Fig. 1. This illustration represents the grinding of the wrist-pin hole in a Diesel engine piston. The piston is 18 inches in diameter, approximately 4½ feet long, and weighs 1800 pounds. The holes were ground within a limit of 0.0001 inch and both holes were, of course, very accurate as to alignment.

Fig. 2 represents the grinding of an irregular shaped casting forming part of a machine tool. This casting is easily held on the flat table of the machine, but it would be rather difficult to clamp to a revolving member, and would also require balancing. The hole which the grinder is operating on is 12 inches in diameter.

Fig. 3 illustrates the grinding of a flat coil spring. This spring is about 14 inches in diameter by 10 inches long. It was necessary to remove from ⅛ to ¼ inch of stock, so that the grinding operation required two or three hours. An accurate hole through the spring was necessary, the limit being 0.001 inch, plus or minus.

The machine illustrated in Fig. 4 is arranged for grinding the wrist-pin hole and crankshaft hole in the connecting-rods used on Knight motors. The work has been removed from the fixture in order to show the arrangement of the parts for holding and locating the connecting-rod while the grinder is at work. One end of the connecting-rod is inserted over a projecting boss or bushing, and the other end is held between two knurled screws. This particular view shows a special extension on the grinding-wheel spindle which was used for grinding the wrist-pin hole. The plug gages for both the wrist-pin and crank-pin holes may be seen standing upright on the machine table.

The operation illustrated in Fig. 5 is an example of work that cannot be revolved on account of its length. All work of this general class, however, is readily ground on a machine of the type referred to. This particular part is the radius-rod of the well-know Walschaerts locomotive valve gear. The wheel-spindle in this case is equipped with a small extension for grinding the hole at the end of this radius-rod.

Another locomotive part is shown on the grinding machine in Fig. 6. This is a heavy cast-steel bracket having a bearing at one side so that it would be practically impossible to grind the hole in any other way. The advantage of using this type of machine for such work is apparent to anyone at all familiar with shop practice.

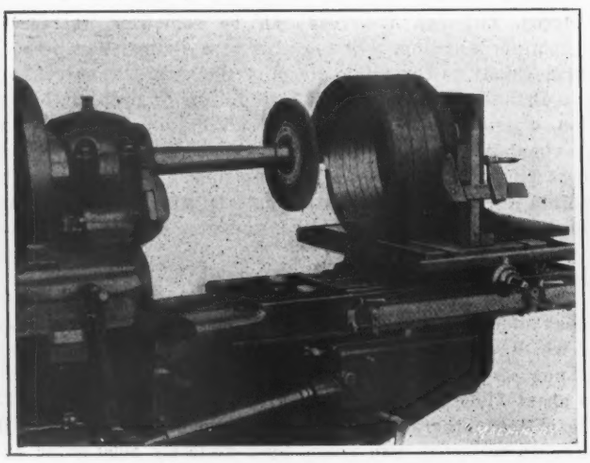

Fig. 3. Internal Grinding Operation on Flat Coil Spring

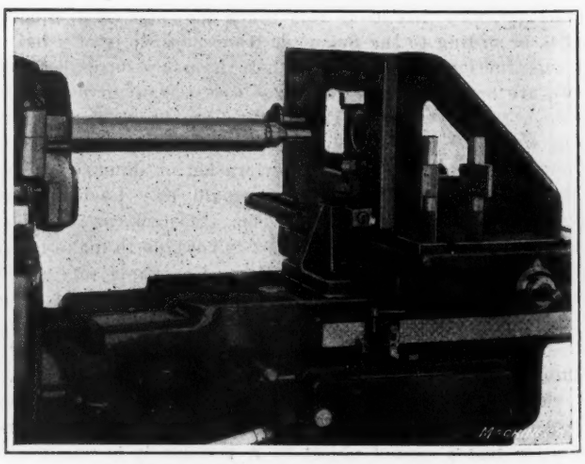

Fig. 4. Grinding Wrist-pin and Crankshaft Holes in Connecting-rods

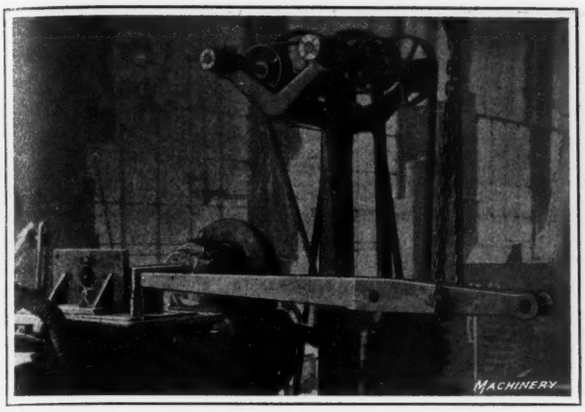

Fig. 5. Grinding Small Hole in End of Radius-rod for Locomotive Valve Gear

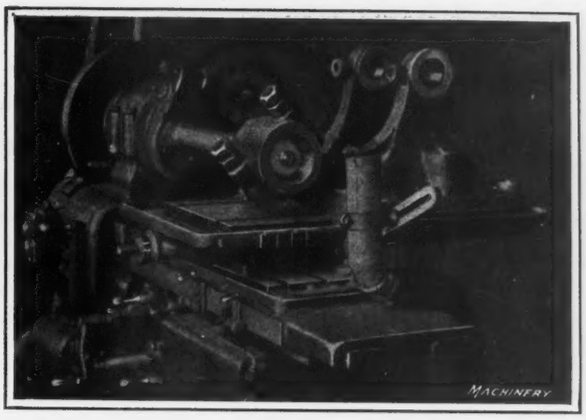

Fig. 6. Grinding Bearing located at One Side of a Heavy Cast-steel Bracket

The operation shown in Fig. 7 is on a locomotive side rod. The grinding operation is on the hardened steel bushings of the knuckle-joint pin hole. The operation illustrated in Fig. 8 is on the equalizing cylinder used in connection with air brakes. Bronze bushings are forced into these cylinders, and as they require accurate machining, the grinder is used. The diameter of the hole is 3½ inches, the length 1½ inch, and the metal removed 0.003 inch. These cylinders are ground at the rate of 110 pieces in ten hours. The work is held in place by a special pneumatically operated fixture. The cylinder grinding machine shown in the different illustrations is made by the Heald Machine Co., Worcester, Mass. F. D. J.

* * *

## USE OF MOLYBDENUM

In this country the use of molybdenum in tool steels, according to reports received by the Geological Survey from various sources, has decreased. A small quantity is used in electric work, for supports for tungsten filaments in incandescent lamps, in Roentgen ray apparatus, and in small resistance furnaces; a number of tons of ore is consumed in making ammonium molybdate for use in chemical work; and a little is used in some stellite; but outside of these practically no uses are known. Efforts have been made to use the blue oxide in dyes, but the process is not known to have been adopted on a commercial scale, although stated in certain papers as a prominent use. Statements that molybdenum is used in smokeless powder, gun steels, and armor plate are constantly reiterated and as positively denied. Abroad molybdenum is apparently used in steel much more than in this country, and French and English steel makers are now using the metal to some extent to replace tungsten, which they have had difficulty in obtaining.

## BELT EFFICIENCY

Belt grip and belt tension are two terms that are often confused. A belt can be made to grip a pulley effectually by increasing its tension, but this throws an undue strain on the driving shafts and often causes hot journals. On the other hand, belts that are properly treated with suitable dressings can be made to grip the pulleys effectually even though running slack. The importance of grip as distinguished from tension cannot be too fully appreciated. Some are of the opinion that when a belt fails to transmit the required power it should have its tension increased by tightening. The effective pulling power of a belt is the difference in the tension on the slack and tight side. It is obvious that the greater the grip of the belt on the pulley, which increases proportionally with the arc of contact, the greater power it will transmit. It follows, therefore, that a belt running slack, provided it grips the pulley effectively, will give a better grip over a greater arc of contact than a tight belt, and that meanwhile the loss of power due to friction will be reduced. Some forms of belting possess less elasticity or resiliency than others and thus transmit power more by sheer weight and tension than by gripping power. The limit of the decrease of the tension value on the slack side of a belt is at that point at which the belt slips on the pulley, the maximum pulling power being attained at the moment preceding the slip. From this it follows that the value of a pliable belt lies in the fact that the tension on its slack side may be decreased to a much greater extent than is the case with a hard belt before slipping becomes evident.

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It is stated that the production of gasoline from natural gas increased from 7,000,000 gallons in 1911 to 104,000,000 gallons in 1916.

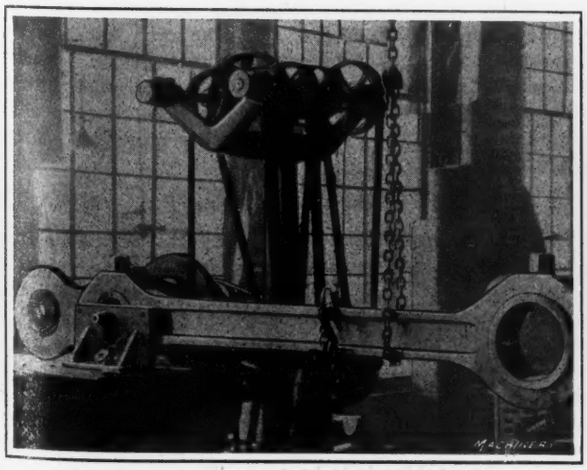


Fig. 7. Grinding Hardened Steel Bushings in Knuckle-joint Pin Hole of Connecting-rod

Fig. 8. Grinding Bronze Bushings in Equalizing Cylinder of Air Brake Equipment

# Organization of a Carburetor Plant

BY FRED H. KORFF

Special Assistant to Factory Manager, Wright-Martin Aircraft Corporation, Long Island City, N. Y.

THE first article on this subject, published in the May number of MACHINERY, outlined the general scheme of organization of a carburetor plant, and dealt in detail with the functions and methods of the employment department, material department, purchasing department, quality department, chemical department, physical department, and methods of inspecting. The present article discusses the work of the mechanical and dispatching departments, and practice in the foundry.

### Mechanical Department

When the carburetor has passed the block and road test satisfactorily, it is given to the mechanical department for production analysis. This department disassembles it, assigns numbers to each part, and makes up a bill of material which specifies the units used, the quantity of material required, and the kind of material which is to be used. This department is composed of a group of smaller machine divisions containing men who are expert on automatic machines, lathes, turret lathes, foundry practice, and patternmaking, etc.

The first step taken is to lay out the operation sheets which specify the manner in which the various parts are to be machined, and the department in which the machining operations are to be done. The laying out of these operation sheets must be gone into exhaustively, for it is very important that no operations be overlooked, and that the proper sequence be followed at all times. As these operation sheets are finished, they are turned over to the different machine divisions, and the men in these divisions analyze the parts and determine the best method to use in machining them. These machine divisions work in close connection with the tool design department and coordinate their ideas relative to the proper design of tools, jigs, dies, and fixtures with those which may be advanced by the tool designing department. In this manner there is a minimum number of mistakes, and after one of the tools has been designed it is as nearly fool-proof as it can be made. While the process of laying out the operation sheets and tool designing is taking place, it is necessary to produce the patterns and castings for the different parts that are to be manufactured.

### Pattern Drawings

In order to expedite production in the pattern shop and eliminate the delays caused by waiting for the pattern layouts, finished machine drawings of the pieces that require patterns are never sent to the pattern shop. Instead, the draftsman who details the parts which call for castings, first makes an accurate line drawing showing the plan, elevation and side views. These views, where necessary, are cross-sectioned and the pattern dimensions added. Tracing cloth is then placed over the drawing and a pencil tracing made of the three views. These views on the tracing cloth enable the draftsman to finish the drawing for the machine shop, adding the necessary dimensions, etc., while the line drawing is shellacked and delivered to the pattern shop in place of a blueprint, thereby eliminating the necessity of a lay-out. This line drawing is primarily a lay-out, as it shows no more than the necessary pattern dimensions.

When the carburetor patterns are made, double shrinkages are allowed all over, and then in place of a brass metal pattern, white metal patterns are cast. When the pattern shop receives these white metal castings, the double shrinkage which had been allowed on the original pattern will leave enough surplus metal to overcome the shrinkage of the white metal, with a sufficient quantity for a file finish in order to bring the pattern down to the final size. By employing this system in obtaining metal patterns, it eliminates a great deal of labor and enables a metal pattern to be obtained quickly. The metal patterns are then gated and put on a plate and aligned for a molding machine. While these patterns are being made, the tool department has been working on the designs of the tools, gages and necessary fixtures required in the factory.

### Bill of Material

A publication is issued by the mechanical department, known as "the bill of material" which specifies the name, part number, kind of metal or material used, and tells whether the part is to be purchased in bulk, finished, or semi-finished, or if it is to be made in the factory. This publication is issued to every manufacturing department, as well as the different service departments, and is a complete record of all the parts which enter into the manufacture of the carburetor. From time to time changes are necessary, and these are handled by the change division of the mechanical department, whose duty it is to see that all old records throughout the factory are destroyed, and the new ones substituted. When the bill of material has been drawn up, the mechanical department uses it as a basis in order to determine mechanical processes of manufacture in conjunction with the production economy which must be maintained at all times.

### Instruction Cards

In order that the process of manufacture may be thoroughly understood by the operators themselves, as well as by the foremen and inspectors, the operation and lay-out division of the mechanical department publishes instructions for each and every operation that is performed. These instructions are printed on small 5- by 8-inch cards contained in a celluloid folder with a hole at the top, so that it can be placed on a hook adjacent to the machine upon which the operation is being performed. These instructions cover in detail the method which is to be followed; for example, assume that a piece of 2-inch bar stock is being used on a hand screw machine. There are four operations—forming, drilling, tapping, and cutting off. The card instructs the operator to pick up the bar stock from the floor, insert it in the machine, and adjust the clutch at the rear of the machine so that the stock will be held securely in the collet, and explains how the forming and other operations should be performed.

### Machine Tool Loading

The method of machine tool loading has been gone into exhaustively, so that production shortages will be eliminated to the greatest extent. The number of actual machine hours available from the different machines in the factory is compared with the hours necessary to produce a given number of carburetors, in order to determine the production possible with the available machines. The machine loading card is 5- by 8-inch in size. At the top of the card is specified the machine name, machine number, and department number in which the machine is to be used. Then starting from the left-hand side of the card are specified in sequence the part

number; operation number; performance, which is divided into quantity, hours and minutes; history, which is divided into percentage allowable for rejection or repairs and the time equal thereto in minutes, the total minutes consumed, the units per motor, the standard quantity of the manufacturing order, the equivalent in minutes to produce the standard quantity, the minutes allowable for contingencies, and the total interval of tie-up in minutes.

Having previously determined in what departments the different parts are to be machined, and the length of time allowable for machining each part, the next step is to allot the machining operations of the different parts to the proper machines, making due time allowances for all contingencies and interferences which may arise. If we assume that the working day is of ten hours' duration, this will permit of loading each machine per day with a certain number of operations, the machine minutes for which, plus a factor of safety for rejections, will not exceed six hundred—or ten hours per machine. Let us assume that we have a total factory machine hour capacity of 6000 machine hours per day and that it has been determined by the time studies that it requires three hours machining time to produce a carburetor. Adding 30 per cent to this for breakdowns, interferences, rejections, etc., we obtain a total of about four hours machining time for each carburetor. We now find that the factory should produce 1500 carburetors per day, as a minimum amount.

In order to obtain the smoothness of production flow desired, it is necessary to determine the length of time for each operation on each machine. Each part number and the number of the operation being performed by a certain machine in a certain department, is entered on the machine loading record card. The quantity of pieces made in ten hours is now entered, as well as the minute machining time required, and the percentage of time allowable for rejections is added, giving a total minute machining time for these pieces. Let us assume that an operation can be performed at the rate of 1200 pieces in ten hours, and that 400 pieces, or a minute machining time equivalent to 200 minutes, is allowed as a factor of safety. The total time necessary to allow for the proper functioning of this operation is 800 minutes, or 0.66 minute per part per carburetor. If there are 60 pieces used on each carburetor, an equivalent of 15 carburetors of this particular part can be adequately produced by one machine in a given day of ten hours. In other words, production time is equal to approximately 40 minutes per carburetor. Therefore it will require about 100 machines for this operation to produce a sufficient number of parts for a production of 1500 carburetors per day. In some cases possibly four or five operations can be performed by a certain machine during a working day of ten hours.

This process is continued for every operation on the various parts and each operation applied to the particular type of machine called for by the loading charts. This necessitates determining the number of working minutes required for the different operations and comparing the total minutes with the number of machine working minutes per day for each machine. By utilizing the machine loading system as outlined, we find that the production obtained is very close to the production desired, and the number of waste hours and lost motion are reduced to a minimum.

### Demonstrating the Tools

When the tools have been designed by the mechanical department, these designs are delivered to the tool-room, where the tools are made, inspected, and delivered to the tool-cribs as specified by the manufacturing order. At the same time the superintendent of the floor and the demonstrating department are notified that these tools are completed. Upon receipt of this notification the demonstrating department withdraws these tools from the tool-cribs, places them on the machine and puts them through the operations for which they were intended, using the proper productive material. If the tool is found imperfect, or a change is desired by the demonstrator, the tool is returned directly to the tool-room. Upon completion of the necessary corrections or desired changes, the tool is sent to the inspection division for examination and if passed by them, is delivered to the demonstrating department. When the tool functions to the demonstrator's satisfaction, and performs the operation as called for, a written notification to this effect is given to the floor superintendent by the demonstrator, the tool being sent to the floor tool-crib awaiting withdrawal for use.

### Dispatching Department

The activities of the dispatching department cover the compiling of schedules relative to production, applying the machine loading records against the actual production schedule obtained, and following up all shortages, changes in design, and production routine. The schedule when it is drawn up is based on the minimum amount of carburetors which are desired to be obtained and covers a certain period. When this schedule has been compiled, it is known as the "normal schedule," and in order to determine at what time a certain part should start in production, a key chart is drawn up based on the time study trials and machine-loading record. This key chart is compiled in the form of hours against a certain number of carburetors which are to be produced on a given date, and specifies the parts in operation which are being started at a certain time so that all may function smoothly and reach the assembly department at least five days ahead of the actual assembling date.

The bulk of production is handled by the general floor dispatcher, who receives his instructions from the chief of the dispatching department relative to what parts are to be started, when they are to be started, and how long they are to be permitted to run on the various machines. It is his duty to follow these parts up, see that they are put into production at the proper time, and eliminate as far as possible any material shortages. It is necessary for him to keep in close touch with the inspectors and superintendents, and so coordinate the duties of both that there will be no delays, for the machine loading record is somewhat complicated, and it requires careful attention to see that the parts are not produced for too long or too short a time.

These floor dispatchers are assisted by the shop clerks in the different departments, whose duty it is to receive the material when it enters a department, and see that it is recorded and delivered to the proper machine. When the machine operations have been completed, it is the shop clerk's duty to see that the material is properly delivered to the next department. In order that production may not be delayed, the superintendent of the dispatching department makes trips throughout the plant, and keeps in close touch with the floor dispatchers and their duties at all times, for it is the floor dispatchers who really handle the bulk of production, and if they do not perform their work satisfactorily, due to the fact that their duties are not thoroughly clear to them, production will be delayed all along the line.

### Practice in the Foundry

In the foundry, open-hearth furnaces are used in preference to the crucible type, as the metal can be heated much more quickly, and there is not as great a loss and expense involved as when using crucibles. Crucibles were used in the past, but were found to be far too expensive when the high rate of production had been reached. When the open-hearth furnaces were placed in operation, a complete conveying system was installed which permits the metal to be carried in a large container to the different molds. By using this method it was found that the molding time was reduced to less than half, and it enabled the metal to be poured at the proper heat, which could not be done when crucibles were used.

Instead of using hand riddles for cleaning and grading the sand, power oscillating riddles are used, one for each mold-

ing machine. This facilitates the handling of the sand and gives a uniform grade at all times. All patterns are mounted on plates, and these plates are used with Tabor molding machines. This method was found to be very efficient for obtaining castings quickly and accurately.

When the cope and drag flasks have been removed, the castings are removed from the sand by means of a large pair of pliers. While the casting is still warm it is plunged into a tank of cold water. As this casting is brass, it does not affect it by plunging it into this cold bath. This is done to remove the various cores, for when the cold water touches the outside surface of the casting, it immediately turns the dampness that is in the core sand into steam, which blows out the sand core from the casting, leaving it very clean. This is a far better method than chipping the core out by hand.

When the sand cores have been removed from the castings, the latter are put into a large tumbling barrel which contains small metal blocks and small tumbling jacks. The castings are left in the tumbling barrel for approximately fifteen minutes, and they are then taken out and put into the standard wooden containers which are used to transfer them from one machining operation to another. When the castings are taken from the tumbling barrel, the sand has been entirely removed and the outside of the casting is comparatively smooth, as all rough spots have, of course, been eliminated by the tumbling process.

The castings are next rough-ground, all the high spots and rough places being ground off. They are then taken to the filing bench, where the rough spots that could not be reached by a grinding wheel are filed. The castings are now free from all high spots, bumps, and fins. This process of cleaning greatly assists in manufacturing, as the casting after being cleaned, will fit the jigs and fixtures more easily. The castings now enter the factory and are sent through the different machining operations which have been laid out for them.

* * *

## DIFFERENTIAL GEAR PROBLEM

BY W. WHEATLEY

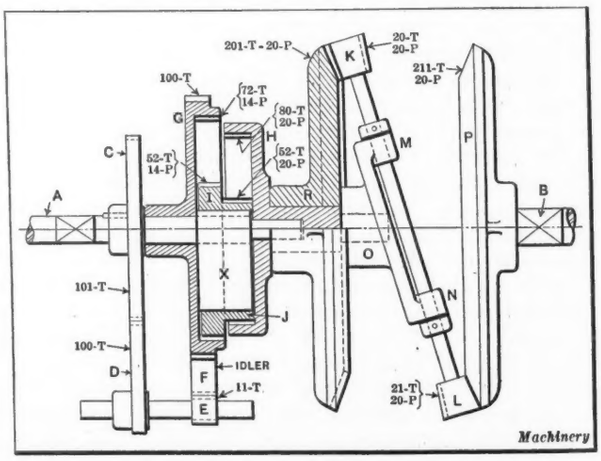
The accompanying illustration shows an arrangement of gears which was especially devised in order that the speed of shaft *B*, which is driven from shaft *A* through the differential, might be reduced to suit the requirements without too much complication. The bevel gear part of the differential has a ratio of 1 to 4220, and it was thought that if this ratio could be divided by 100,000 the result would be satisfactory, so with this in mind the gears were computed. A general explanation of the mechanism will first be given. *A* is the driving shaft, which carries spur gear *C* and the eccentric *X* keyed to it. Shaft *A* revolves in the hubs of gears *G* and *H*, the latter gear revolving in the hub of the stationary bevel gear *R*. The yoke *O* is keyed to an extension of the hub of gear *H* and revolves with it. The bevel gear combination is similar to a form of differential which originated with Professor MacCord (at one time chief draftsman for Captain John Ericsson), and first described about 1878.

By referring to the illustration, it will be apparent that during the period of time in which yoke *O* is making one complete revolution, the gears *K* and *L* will make 201 ÷ 20, or 10 1/20 revolutions. Now, since gear *L* has 21 teeth, 21 × 10 1/20, or 211 1/20 equals the number of teeth that would be required for gear *P*, if it were to remain stationary, But having only 211 teeth, gear *P* must move 1/20 of a tooth for each complete revolution of the yoke *O*, which means that *O* must make 211 times 20, or 4220 revolutions to 1 of gear *P*.

In order to obtain the desired reduction of 1 to 422,000,000 between shafts *A* and *B*, an arrangement was devised which would multiply the ratio $\frac{1}{4220}$ by $\frac{1}{100,000}$. Gears *G*, *I*, *J* and *H*, compose an epicyclic or planetary train of gearing which is well known, and which has a ratio of 10 to 1; while the train *C*, *D*, *E*, and *G* serves to retard the motion of *H*, and has a ratio of 100,000 to 9999. Assume that *G* is stationary and that *C* is inoperative; then, if shaft *A* is revolved once, *H* will also be turned in the same direction, and gear *I*, acting in the internal gear *G*, reduces this movement $\frac{72}{80}$ of a turn, so that after the shaft *A* has revolved once, gear *H* has advanced but 1/10 of a revolution. Now, if the movement of shaft *A* and of the eccentric *X* be disregarded, and if the gear *C* be revolved one turn in the same direction that *A* was turned in, the gears *D*, *E*, and *G* will cause gear *H* to turn $\frac{101 \times 11 \times 72}{100 \times 100 \times 80}$, or $\frac{9999}{100,000}$ revolution, in the opposite direction.

Therefore the combined effect of these actions will cause *H* to move in the same direction as *A*, an amount represented by the difference between these ratios; that is, gear *H* will move $\frac{1}{10} - \frac{9999}{100,000} = \frac{1}{100,000}$ revolution, for each complete turn of shaft *A*. It is now apparent that the ratio of movement between *B* and *A* is $\frac{1}{100,000}$ of the ratio of gear *P* to the yoke *O*, or $\frac{1}{100,000} \times \frac{1}{4220} = \frac{1}{422,000,000}$.

The amount of reduction that is thus produced may better be understood when it is remembered that if shaft *A* makes




Gear Differential for obtaining Gear Reduction

100 revolutions per minute it will require more than eight years to obtain one turn of shaft *B*. While this differential may not be of much practical use, it is an excellent example in gear reduction, which should prove of interest to those who are interested in gearing and the solution of gear problems.

* * *

## SHEARING STRENGTH OF CONCRETE BEAMS

The Emergency Fleet Corporation, faced with the problem of constructing ships of concrete, found it necessary to make tests of concrete beams in order to determine the proper design of construction for these vessels. As a result of the tests made, it was found that, in the case of deep beams the standards heretofore accepted had been too low and that much larger shearing stresses could be used with safety. The studies so far made will have an important bearing upon the use of concrete in other structures, such as buildings and bridges. In some cases, concrete has not been used because of limitations in shearing strength imposed by the standards that have prevailed up to the present time, but with the revised standards there will be an opportunity for a wider use of concrete.

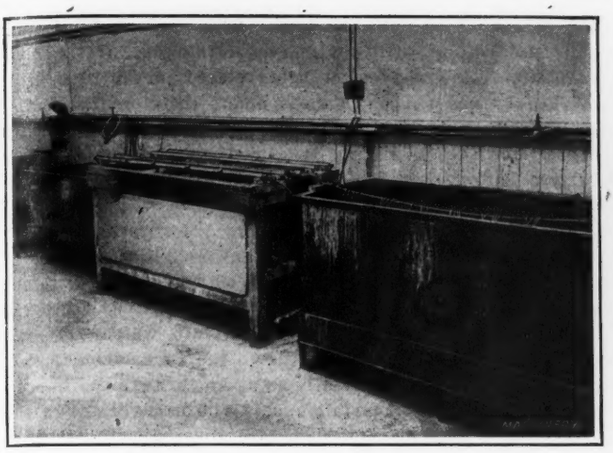


Fig. 1. The Cyanide and "Lyco" Baths

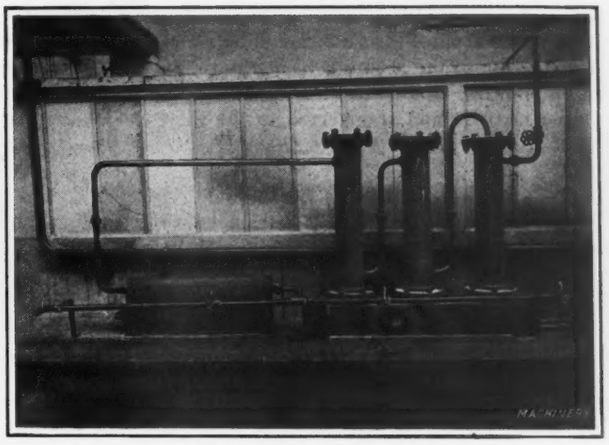


Fig. 2. Air Drying and Heating Apparatus

# Rustproofing Cast-iron Parts

A METHOD of rustproofing cast-iron parts has been developed by Hans Renold, Ltd., Manchester, England. While the following description relates to the process as used for rustproofing fuse bodies, it can also be applied to the rustproofing of cast-iron articles other than munitions of war. The process is based on the fact that a film of magnetic or black oxide of iron, $Fe_3O_4$, is formed on the surface of iron castings when heated to a temperature of 700 degrees C. or over in an oxidizing atmosphere. This film affords considerable protection against rusting, but will, in the course of time, on exposure to the atmosphere, become converted to brown oxide of iron, $Fe_2O_3$, hydrated, that is, iron rust. In order to prevent this atmospheric action, the articles are dipped while at 700 degrees C. in cottonseed oil. The heat causes the oil to form a varnish or protective coating which thoroughly impregnates the oxidized surface. The details of the process were worked out by the firm of Hans Renold, Ltd., to treat a weekly production of 40,000 fuse bodies, the operation of the plant requiring one man and eight girls per shift.

### Cleaning

It is essential that the articles be absolutely clean before heating. They are first suspended in a bath of hot "Lyco" (Fig. 1), the strength being 11 ounces per gallon. The bath contains 40 gallons, and is renewed every two months. The fuse bodies are placed on hooks and suspended in this bath for about three minutes to remove all traces of grease and oil. They are then washed in cold running water for a few seconds and transferred to an electrolytic bath, which consists of cyanide of potassium (98 per cent pure) in the proportion of 4 ounces per gallon of water. If less pure, a greater proportion is required, that is, at 80 per cent, 5 ounces to the gallon. A purity of less than 80 per cent is not recommended. This bath contains 35 gallons, and is made up every two or three days. The fuse bodies are suspended by steel hooks from cathode brass bars which stretch across the tank. The bodies, therefore, form the cathodes, and iron plates suspended in the bath form the anodes.

The bodies remain there five minutes, and when a current of electricity of 25 amperes at 8 to 10 volts is passed through the bath, a chemical action takes place at the surface of the articles, the result being that all foreign matter is removed. The bodies are then placed in cold running water for washing off the cyanide, after which they pass to a hot water tank, where they remain three or four minutes in order to become thoroughly warm, to facilitate drying.

### Drying

After being washed, the articles are taken to a heated sawdust bin and dried; the sawdust is then blown off and the drying completed by hot air. The blast is supplied by a compressor, the compressed air being dried and heated by the apparatus shown in Fig. 2. The cold, damp air enters at the top of the first chamber (shown at the right) and the moisture from it collects at the bottom. The air passes through a central pipe and out at the top, and is led to the bottom of the second chamber. There is a perforated cylinder containing calcium chloride in this chamber, through which the air must pass and where practically all the remaining moisture is absorbed. The air is then filtered by passing through a third chamber containing cotton-wool. The second and third chambers need replenishing about once a month. From the top of the third chamber the air is led to the heating apparatus. This consists of a sheet iron box, triangular in section. The air pipe extends inside along the

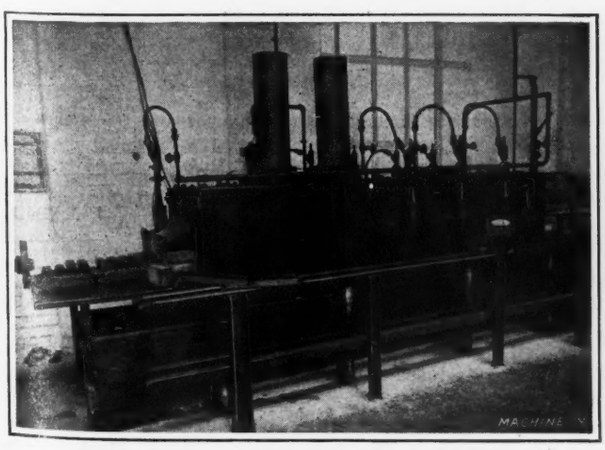


Fig. 3. Reverberatory Gas Furnace

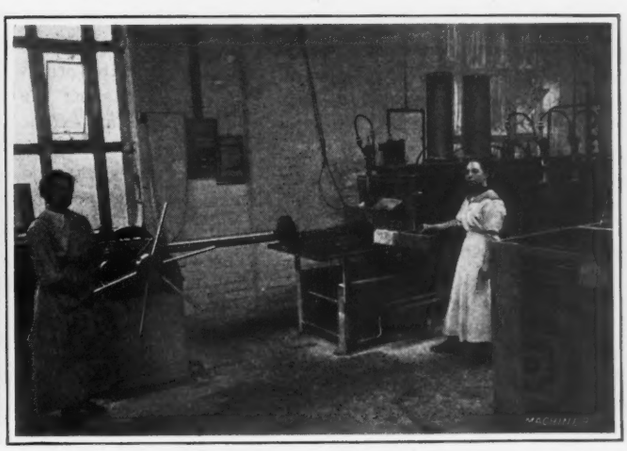


Fig. 4. Ram for loading the Furnaces

top, and a pipe with a series of bunsen burners is situated underneath about 6 inches below the air pipe. These burners heat the air to the required temperature, and it then passes to the blowing taps or nozzles. After drying, the bodies are placed in trays and transferred to the inlet end of the furnace.

### Heating

The bodies are placed in a Richmond reverberatory furnace, 9 feet long, 10½ inches wide, and 12 inches high, as illustrated in Fig. 3. The furnace will accommodate about 120 bodies at one time, and 400 bodies per hour can be treated quite satisfactorily. A ram, as shown in Fig. 4, actuated by a handwheel and rack, pushes the plates carrying the fuse bodies into the furnace.

A small hood is built over the inlet to facilitate the loading of the plates. A brick hood is also built over the exit so as to conserve the heat of the plates and prevent the bodies from being chilled. The plates for carrying the bodies have sets of lugs cast on the upper surface, on which the bodies rest. There are three lugs for each body, and they are cast to a knife-edge in order that the body may not be marked, which was found to be the case when it was placed on a flat surface. The bodies are placed nose downward on these lugs, each plate carrying twelve bodies.

The heat is so arranged that the temperature of the bodies gradually rises until, by the time they reach the middle of the furnace (about ten minutes), they are heated to about 700 degrees C., and this heat is maintained until they pass out of the furnace, the whole heating taking twenty minutes. The nature of the flame must be such that the atmosphere of the furnace is an oxidizing one, so as to form the magnetic oxide of iron, $Fe_3O_4$, on the fuse bodies, at a temperature of 700 degrees C. This means admitting as much air and as little gas as possible, consistent with the maintenance of the temperature. If the color produced after quenching is gray, the proportion of gas to air is too great, and the burners must be readjusted.

Fig. 5. Oil Tank in which Bodies are dipped to produce Rustproof Coating

Adjustment of temperature may be made by admitting more or less gas, but it takes about an hour before the furnace responds to this adjustment. Control, however, may be exercised by passing the bodies through the furnace more or less quickly. Care must be taken to shut down the gas when the last bodies of the lot are coming through; otherwise, due to the less amount of cold material entering the furnace, the temperature will rise, even to such an extent as to cause blistering of the bodies, which occurs at 900 degrees C. It is advisable to run the furnace fully charged for as long a period as possible. The deformation of the fuse bodies due to the temperature attained (700 degrees C.) is quite negligible.

### Quenching

The quenching tank is placed at the end of the furnace. This tank, which is shown in Fig. 5, is 10 feet long, by 2 feet wide, by 4 feet 6 inches deep, and is let into the floor so as to bring the level of the tank 2 feet from the ground level. The top of the tank is therefore 5 inches below the level of the furnace floor, and a sloping iron plate connects the furnace floor with the tank. This tank is filled with cottonseed oil to within 3 inches of the top. If the body comes to rest quickly after being placed in the bath, it is marked by any surface it rests upon; therefore the bodies must not be dropped directly, and must be cooled to such a degree that the oil coating is formed evenly over the whole surface before they come into contact with the conveyor, which carries them out of the oil tank.

For this reason they are immersed for seven or eight seconds in the main body of the tank and then transferred to a hopper fitted with baffle plates, which is situated in the same tank. They fall from side to side until they reach the conveyor at the bottom of the tank, into which they fall comparatively lightly, and, owing to the time taken in falling, they are cooled sufficiently so as not to take the impression of the surface they fall upon. The baffle plates in the hopper have rounded sides and are covered with wood or linoleum so as to avoid marking the fuse bodies.

The hopper is situated at the furnace end of the tank. The red-hot castings are lifted from the plate by means of a fork. If the bodies are thoroughly submerged, no blazing will result. The temperature of the oil should be such that the castings may be easily handled when the conveyor carries them above the level of the oil. The conveyor, also shown in Fig. 5, consists of a series of horizontal buckets of a length to suit the width of the tank. These buckets are mounted on chains which are driven at a speed of 18 inches per minute by a motor through a reduction gear. The conveyor is situated in the oil tank at an angle, the lower end being submerged at the end near the furnace, and the upper end projecting above the tank at the farther end.

The hot oil is drawn from the top of the tank by a circulating pipe placed horizontally inside the tank immediately below the surface of the oil. It is pumped to the cooler by a small reciprocating pump, and the cooled oil runs by gravity back into the bottom of the tank. The temperature of the oil in the tank should never exceed 100 degrees C., as otherwise blazing may occur. An oil cooler, of the rotary drum type, is used for cooling. The rotary drum carrying four series of concentric plates revolves at 11 revolutions per minute, and dips into the oil, which adheres to the plates. Cold air is drawn through the cooler and comes in contact with the film of oil on the plates, thereby cooling the oil.

### Drying

The bodies are picked off the conveyor and transferred to the drying bins, where they are dried in sawdust. A good deal of sawdust is necessary for complete drying, and, as fine sawdust is difficult to obtain, coarse sawdust is first used for absorbing the greater portion of the oil. The body is then blown clean by the hot air blast and the small threads are dried out with fine sawdust. A final blowing is given, and the fuses are then ready for inspection.

### Some of the Difficulties that were Experienced

Some of the fuses had a slight copper deposit on the surface after heat-treatment. On investigation, this proved to have been deposited from oils and cutting compounds during the heating of the fuse bodies. These oils had been

used in the machining of brass parts, and it was found that a chemical action had taken place between the free acids of the oils and the copper of the brass fuses, etc. The coppering is entirely prevented by the use of the cyanide cleaning bath. If copper should appear, it can be removed by immersing the body in diluted nitric acid, after which the bodies must again pass through the furnace.

Insufficient oxidation results in the finished bodies having a gray appearance. This is due to the atmosphere in the furnace containing too much gas, and is overcome, as previously mentioned, by admitting as little gas and as much air as possible consistent with the maintenance of the temperature.

Blistering, when it occurs, is due to overheating, and, as stated previously, occurs at 900 degrees C. or thereabouts. Finding the correct size for gas nozzles remedies this trouble.

Oil-sweating is due to all the oil not being absorbed. The final drying in fine sawdust and a thorough blowing with hot dry air overcomes this difficulty.

* * *

## RELATIVE HARDNESS OF SOFT IRON AND COPPER[1]

The following record of experiments performed at the Research Laboratory of the General Electric Co. is of commercial value in that it shows that by the use of an electric furnace ingot iron can be annealed to such a degree of softness that it may be substituted for copper in many cases where copper is now employed. The experiments were undertaken to determine how soft the purest grade of commercial iron produced in this country can be made after proper annealing and how its hardness compares with that of copper. The material tested was American ingot iron obtained from two different manufacturers in bar form, 5/32 inch in thickness. Ordinary cold-rolled copper of two thicknesses, ¾ and ⅝ inch, was used in the comparative tests. The analysis of the two makes of ingot iron was as follows:

| Constituents | No. 1 | No. 2 | Constituents | No. 1 | No. 2 |
|---|---|---|---|---|---|
| Fe | 99.915 | 99.908 | Si | trace | none |
| C | 0.05 | 0.06 | S | 0.010 | 0.010 |
| Mn | 0.02 | 0.02 | P | 0.005 | 0.002 |

The hardness tests were made by the standard Brinell method, the load applied in all cases being 500 kilograms and the diameter of the ball, 10 millimeters. Two different impressions were made upon each sample for checking purposes. The iron was subjected to eight different treatments as follows:

TABLE 1. RESULTS OF BRINELL HARDNESS TESTS ON IRON SPECIMENS

| Iron | Brinell Hardness | |
|---|---|---|
| | No. 1 | No. 2 |
| 1. Unannealed as received in sheet bars | 97.6 | 95.2 |
| 2. Factory-annealed | 79.4 | 80.0 |
| 3. Factory-annealed sample reannealed in hydrogen | 57.8 | 63.0 |
| 4. Hydrogen-annealed | 62.2 | 61.0 |
| 5. Vacuum-annealed | 62.2 | 65.8 |
| 6. Annealed in closed copper tube | 66.6 | 66.0 |
| 7. Cold-rolled to two-thirds of original thickness after a hydrogen annealing | 95.7 | 95.7 |
| 8. Cold-rolled as received to two-thirds of original thickness | 110.5 | 112.5 |

*Machinery*

1. A sample of the iron as received unannealed in sheet bar was first tested.

2. A commercial factory annealing was given to another sample wherein the temperature was held at 765 to 775 degrees C. for about eight hours in a closed annealing pot.

3. The factory-annealed sample, after being tested, was reannealed in hydrogen at 900 to 950 degrees C. for three hours.

4. Another set of samples was annealed in hydrogen at 900 to 950 degrees C. for three hours without a previous factory-annealing.

5. A sample of the iron was subjected to vacuum treatment and annealed at 1000 degrees C. for about two hours.

6. Samples were enclosed in a copper tube closed at each end with a copper plug, so as to make it nearly air-tight. This tube was placed in a closed electric tube furnace and annealed at 950 degrees C. for three and a half hours.

7. A hydrogen-annealed sample from the fourth method of treatment was rolled from 0.312 to 0.208 inch, or reduced to two-thirds of its original thickness.

8. A piece of the original sheet bar as received was given the same treatment as the samples in the seventh method.

The third and fourth methods of treatment, called Ruder's anneal, produced the best results. This was carried out in a resistance furnace consisting of a porcelain tube wound with platinum ribbon. The tube was enclosed in a steel casing containing an aluminum oxide insulation. The hydrogen was dried and highly purified. The fifth method of treatment was accomplished in the Arsem vacuum furnace, and gave the next best results. This furnace consists of a water- and air-tight casing containing a graphite grid or helix held in water-cooled copper terminals and enclosed by a graphite screen.

Both the hydrogen and vacuum methods are said to improve considerably the magnetic properties of commercially pure iron and alloys. They not only anneal the iron but also largely reduce its impurities, such as oxygen, carbon, sulphur and phosphorus. The results of the two Brinell hardness tests on the treated specimens are given in Table 1.

It is of interest to note that the hydrogen- and vacuum-annealed iron may be whittled with a jack-knife as easily as commercial copper.

TABLE 2. RESULTS OF BRINELL HARDNESS TESTS ON COPPER SPECIMENS

| Copper | Brinell Hardness | |
|---|---|---|
| | No. 1 | No. 2 |
| 1. Unannealed copper bar | 82.2 | 79.2 |
| 2. Unannealed copper hammered to two-thirds of original thickness | 87.4 | 96.8 |
| 3. Commercial annealed copper | 40.6 | 40.2 |
| 4. Commercial annealed copper rolled to two-thirds of original thickness | 89.4 | 92.6 |

*Machinery*

### Treatment and Hardness Tests of Copper

Different treatments were tried on the copper as follows:

1. Commercial copper bar as received was tested without any treatment.

2. Commercial copper bar ⅝ inch thick was hammered cold to two-thirds of its original thickness.

3. A piece of copper bar ¾ inch thick was annealed in a commercial gas furnace to about 600 degrees C. so that it was dead soft.

4. A piece of the same bar after receiving a commercial annealing was rolled to two-thirds of its original thickness.

The Brinell hardness values in Table 2 show the results of the foregoing treatments.

* * *

The extent of the rise in prices of iron products in Germany during the period of the war is indicated by comparative prices given in a recent number of *Engineering* for girders and bar iron. The price of girders in August, 1914, was $27 per ton, and in March, 1919, $105 per ton; the price of bar iron in August, 1914, was $23 per ton, and in March, 1919, $109 per ton.

[1]Abstract of an article by F. C. Kelley in the "General Electric Review."

JUNE, 1919

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## IMPORTANCE OF SUPPLYING REPAIR PARTS PROMPTLY

The machine tool builder is likely to consider the supplying of repair parts as a necessary trouble, incidental to his business. But the supplying of repair parts is really a very important part of the business, and one which, if properly attended to, in no small measure increases the hold of the manufacturer upon his customers. When a new machine has been ordered there is seldom any criticism of the maker should the delivery happen to be a week or so behind the time set; but when a machine has been installed for some time and is regularly in use, it is a matter of considerable importance to keep it running, and if, for any reason repair parts are needed, there would be just criticism of the machine builder if they did not arrive within a week of the date promised. The prompt supply and the keeping of promises for the delivery of repair parts is therefore important, because the customer may be seriously inconvenienced by interruption in the operation of a machine already installed.

The manufacturer who has acquired a reputation for careful attention to this end of his business, so that machines of his manufacture need not long remain idle when temporary breakdowns occur, has a strong selling argument, because in many classes of machines that is an important point for consideration, next to design and workmanship. Nothing is more aggravating to the manager of a manufacturing plant than to have expensive machines standing idle for long periods because of breakdowns.

* * *

## INTERCHANGEABLE MANUFACTURING WILL DEVELOP FOREIGN TRADE

Although confusion and uncertainty now exist in all European industries, with the peace treaty signed trade should again begin to flow through the reopened channels of commerce. European competition in machinery and tools will be strenuous, and the product of American manufacturers must be not only of the highest quality, but sold at prices to compete successfully with European products, even while we pay higher wages than foreign manufacturers.

In a series of articles on interchangeable manufacturing, beginning in the July number of MACHINERY, it will be shown that higher labor cost does not mean higher production cost, provided the production methods are so systematized that every unit of effort is coordinated toward the economical completion of the finished product.

Notwithstanding higher wages here, American manufacturers can compete successfully with the European markets by adopting completely worked-out methods for interchangeable manufacturing. The application of principles that have been gradually developed over a period of years enables them to produce in quantities, at low cost, without necessarily employing highly skilled labor, except for certain operations. In the past, many products have been manufactured on the interchangeable basis, but it is quite certain that the next few years will see developments along these lines greatly surpassing any that have taken place in several decades previous to the war.

The advantages to be gained through interchangeable manufacturing are too well known in the mechanical field to need repetition here, but the methods that must be followed in order to manufacture on a strictly interchangeable basis are not so well known; in fact, many of these methods have become thoroughly appreciated only through the requirements for both rapid and accurate methods of production that were, by necessity, adopted during the war. Many of the problems that seem quite simple, when only a few parts are to be made of the same kind and size, become quite formidable and require extensive experience and knowledge in their solution, when thousands of parts are to be manufactured on an interchangeable basis. Some of the most widely known firms in this country have successfully solved the problems met with in this work, and it will be the purpose of the series of articles beginning in the July number of MACHINERY to record some of the important phases of interchangeable manufacturing. The more widely these principles are understood, the more cheaply will American manufacturers be able to produce, and the more effectively to meet foreign competition both at home and abroad.

* * *

## THE HUMAN FACTOR IN PRODUCTION

Manufacturers are beginning to see that too much attention has been paid in recent years to systems, and too little to the problems of handling labor so as to promote satisfactory relations between employer and employe. During the war period, there was no time to spare for the working out of problems of this kind, but now that peace has come and the industrial pace has slackened, considerable attention is being paid to the human factor as a link in the industrial chain of production.

The man who works with his hands is coming more and more into his own; and it is recognized that no matter what the system and the facilities for manufacturing, if the man behind the machine cannot work with a contented mind and under conditions that assure his physical well-being, he cannot produce the best results. Paying wages that permit an American standard of living is not the only thing necessary to obtain the highest human efficiency. An important factor is provision for the health of the workers, by medical attention right in the plant, provided the shop is large enough to permit this. Various phases of "welfare work"—so called for lack of a better name—are also of importance. Some men are unable to look out for their own general interests properly, and these men need disinterested advice and help, such as the right kind of welfare director can give them.

It is interesting to note that at the present time there is a decided increase in the interest taken in the working conditions and in the physical and mental well-being of the men in the shops, which doubtless will prove a great help toward a better understanding between employer and employe.

# Would a Reduction in Machine Tool Prices Stimulate Trade?

An Interview with FRANK A. SCOTT, Vice-president of the Warner & Swasey Company

DO reduced machine tool prices stimulate trade? Before answering this question, the justification for a reduction in the price of machine tools at this time ought to be reviewed. Assuming that prices during the war were based upon costs at that time and allowed a reasonable profit, what changes in manufacturing conditions have taken place that permit of a reduction at this time? As far as I can see, no such changes have come about, and manufacturers of machine tools who did not unduly increase their prices during the war period are in no position to reduce prices now.

### Wages of Labor, Cost of Materials, and Taxes Remain Practically Unchanged

The three main factors that influence the cost of production at the present time are wages, cost of materials, and heavy taxes. Let us analyze each one of these factors separately to see whether any change has taken place since the armistice that would result in reduction in the cost of manufacturing machine tools.

There has been no reduction in wages and it is very doubtful if there will be any material reduction in the cost of labor for a long time to come. In fact, it is not desirable that there should be a reduction in wages for many reasons, chief among which is the fact that wherever any large body of our population has worked its way to a higher standard of living, it is desirable from every standpoint that such higher standard be maintained. The payment of high wages, however, necessitates higher selling prices for the manufactured products, so that, while wages remain at their present level, no reduction in the prices of the products of labor—in this case machine tools—is justifiable.

Another factor that influences the cost of finished products is the cost of raw materials. There has been a slight reduction in the cost of pig iron, which is the basic material for all the other materials that enter into the making of machine tools, except brass and bronze, of which very small quantities are used. The reduction in the cost of pig iron, however, has been comparatively small; and furthermore, since the cost of materials is a small item as compared with the total cost of the completed machine tool, the percentage of reduction in price that would be possible on account of the reduction that has taken place in pig iron would be very small. For example, a reduction in pig iron amounting to 20 per cent would mean a reduction of not more than 3 or 4 per cent in the cost of a high-class machine tool. This decrease in cost, however, is counterbalanced by the increase in the overhead chargeable to each machine, which is a direct consequence of the decreased production at the present time compared with the volume during the war period. Furthermore, most manufacturers had stocked up with large quantities of materials at the maximum war prices, in anticipation of difficulties in obtaining materials if the war had continued another year or two, and are now using these materials in the production of machine tools, so that the slight reduction that has taken place will not directly benefit the machine tool builder for some time to come.

### The Important Influence of Taxation

Taxation is a matter that is frequently overlooked, but that plays an important part in the maintaining of present price levels. With taxes as high as they necessarily must be for years to come, in order that the Government may be able not only to meet the enormous interest charge on its several loans, but also to gradually pay off the principal of these loans, it is evident that even with the present high prices the manufacturer's actual net profits may be smaller than they would have been in normal times with much lower prices, even though labor and materials had been as high as they are now. High taxes must be maintained for a long period, and hence present price levels are likely to remain, with comparatively slight changes, over the same period.

### Would the Trade be Stimulated by Reduced Prices of Machine Tools?

Now having analyzed the conditions that obtain in the machine tool trade with regard to the main elements that determine costs, we are ready to consider the main question propounded as to whether reduced machine tool prices would stimulate trade. Even though there is no justification for price reduction on account of reduced costs, the manufacturer of machine tools might conclude that it would be wise to reduce the price, provided such a reduction would produce a larger volume of business, so that, while the profits on each sale would be smaller, the total returns on a large volume of sales might be greater, and the overhead per unit of output thereby reduced. Were this reasoning correct, there would be a strong argument in favor of a reduction in prices at the present time, because an increased volume of business would mean permanent employment of all those engaged in the trade, and would make possible the keeping together of the organizations that have been built up with a great deal of care, cost, and effort; on the whole, such a condition would greatly benefit the trade in various directions. However, if a reduction in prices should fail to stimulate trade, none of these objects would be obtained, but on the contrary, the profits of the manufacturer would be reduced to a point where he would place his whole business in a dangerous financial position.

Let us analyze this question. A reduction in the prices of goods that are used to gratify personal desires, such as clothing, furniture, table luxuries, etc., may indeed stimulate buying; but in the case of products or machines that are bought because of the returns that are expected from them in their employment, the condition is entirely different. When a manufacturer buys a machine tool he makes an investment on which he expects to realize a return quickly. It is of less importance to him what the price is than that he has work to do on that machine which can be performed better or quicker in this way than in some other manner. He will not put off buying for several months, expecting a lower price, because meanwhile he loses the profits that he would realize if he put the machine to work at once; nor would he stock up with machine tools if the price were reduced simply because of the lower price, unless he had immediate use for the machines. It is therefore difficult to see how a reduction in machine tool prices would stimulate trade. The manufacturer who defers buying in expectation of lower prices hinders his production and reduces the profits that he could obtain from the immediate use of the new machines he requires, and few manufacturers would be short-sighted enough to forego immediate profits in order to make a possible saving in the purchase price of machines now needed. Machine tools that have not already been reduced in price are not likely to be reduced until far in the future, when, due to a decrease in taxation and new and improved methods of production, we may be able to reach a lower price level than the present.

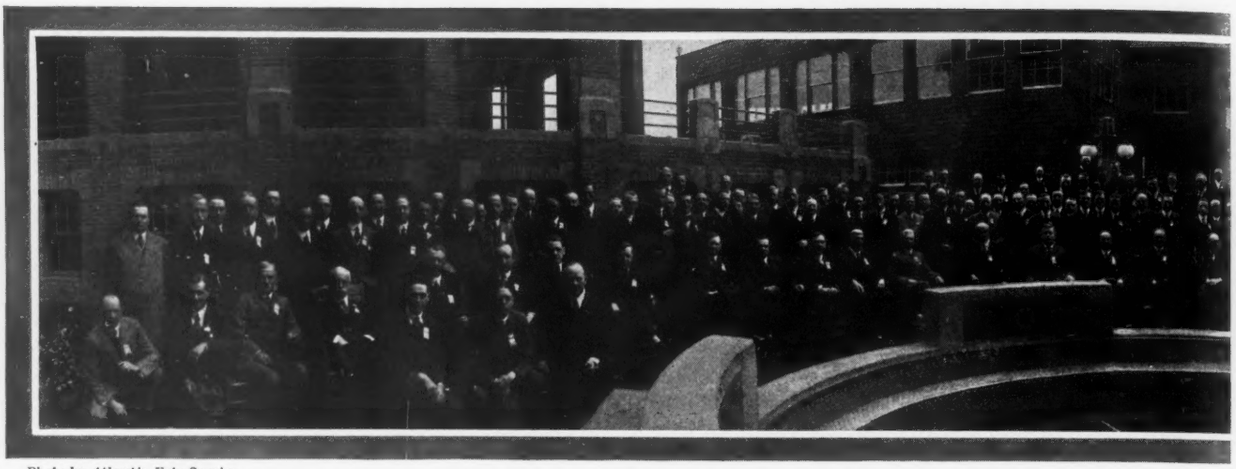


*Photo by Atlantic Foto Service*

# National Machine Tool Builders' Convention

AT the semi-annual convention of the National Machine Tool Builders' Association, in Atlantic City, May 12 and 13, many problems that have agitated the minds of the machine tool builders during the past months were discussed, and definite policies were decided upon in regard to many unsettled questions. There was a large attendance of machine tool builders and, in addition, there were many foreign dealers present, practically all the European markets being represented.

At the general sessions, which were held May 12, several papers both of general interest and of specific value to machine tool builders were presented. Mark Sullivan, of *Collier's Weekly*, who has recently returned from Europe and who has been in Paris during the last few months, spoke on the present conditions in Europe, pointing out many important facts not ordinarily taken into account when making an estimate of the European industrial situation.

Charles E. Hildreth, president of the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., and general manager of the association, made a brief statement referring to his recent appointment to Washington to direct the inventory and sales of the machine tools owned by the United States Government. Colonel Hutchinson, also of the Sales Division of the Ordnance Department, in a brief statement, made reference to the same subject.

### The President's Address

The president of the association, A. E. Newton, vice-president and general manager of the Reed-Prentice Co., Worcester, Mass., in his address, dealt in considerable detail with the commercial conditions in the machine tool trade. Mr. Newton's remarks were, in part, as follows:

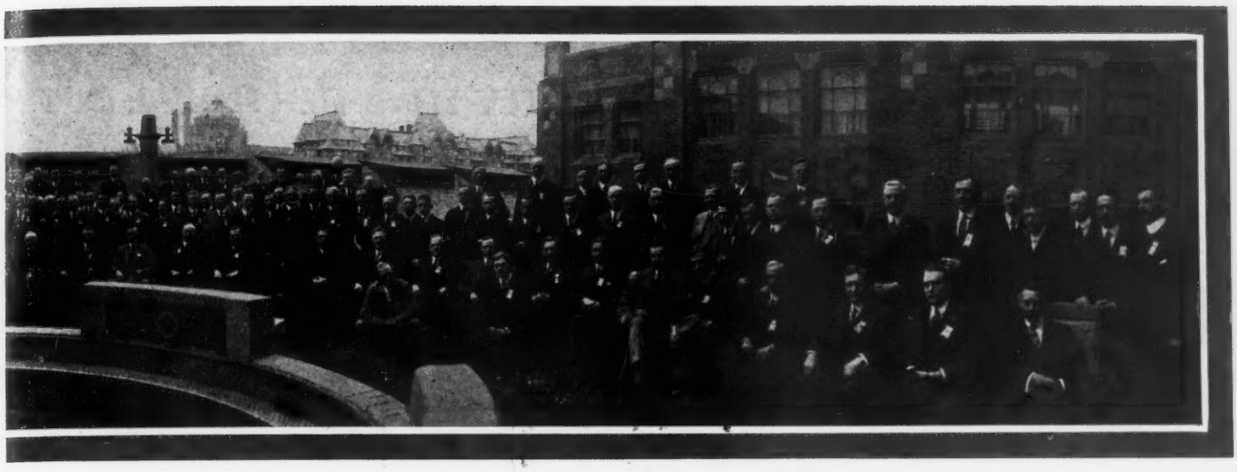
"Our association was formed primarily for the protection of its members. Previously, and at the time of its formation, there were very few machine tool builders who had any accurate cost records, and some had no cost records at all. These manufacturers, in deciding upon selling prices, were generally guided by the price set by a competing manufacturer, thinking probably that this competitor knew his costs; thanks to an educational campaign carried on by the association, practically all of those who had been guessing about their costs adopted a comparatively accurate and complete method of cost accounting. This has resulted in prices being made with due reference to the cost and providing for a margin of profit, so that, for several years, machine tool price lists have been regarded as final, and purchasing agents have given up trying to talk about price cutting. We can take it for granted that, when manufacturers know their costs, they will not sell their product below cost.

"Ever since the beginning of this association, prices on machine tools have constantly increased, due to increased labor and material costs, and to the development of designs, making the machines heavier and equipping them with more and more labor-saving devices. However, the margin of profit has never been adequate, except, perhaps, during 1917 and 1918, when prices were advanced as a matter of protection, as it was dangerous to sell many machines for delivery several months ahead, owing to the fact that conditions were changing so rapidly that no one could tell what a machine would cost four or five months in advance.

"Now machine tool prices are being reduced, an ordeal as dangerous to us as friendly and generous competitors as retreat is to an army. It is much easier to maintain an organized unbroken front when advancing, or even holding a position, than while in retreat. Let us be sure that our retreat is merely a withdrawal to a stronger position. Why are the prices being reduced? The real answer is competition. Evidently we are to compete on a lower plane of profit than we have become used to during the past three or four years. During this period of readjustment, the members of this association should renew their studies in the science of cost accounting, for we must not let a manufacturer who knows the least about his costs fix our prices.

"There is no more profitable occupation for the executive head of a company at this time than a study of costs and their relation to selling prices; but if the percentage of profit, as shown by the cost records on each machine or lots of machines made during the year, is compared with the percentage of profit as shown by the yearly statement, there is a surprise in store.

"It is doubtful if any company represented here can reconcile its cost records of individual machines with the total cost of doing business for the year. We can record more or less accurately our direct labor and material costs, but the overhead is still more or less unfathomed. Suppose you sell for $2000 a machine that cost you $1000. (When I say cost, I mean the cost as shown by the records of your cost accounting department.) Apparently you have made a profit of $1000, or 50 per cent of the selling price. I feel safe in saying that none of the companies represented in our membership ever realizes more than 50 or, perhaps, 60 per cent of such profits in cash, available for payment of excess profit taxes or dividends. If that is a fact, and I believe it is, then, of the apparent $1000 profit, you have, in reality, only $500 or $600. This is unfortunate, for when we decide to reduce prices, we usually consult our costs as shown for the various individual machines, and neglect to consult our real costs as shown by our annual statement. After looking up the costs as before stated, perhaps we reduce the price 20 per cent, thinking that we will still have $600 profit on this machine, while, in reality, we will only have $100 or $200 left as a real profit. In other words, instead of giving



up 40 per cent of your profit, as you had intended, you are in fact giving up from 70 to 80 per cent of your actual profit.

"When I decided to bring this subject to your attention, I consulted two well-known auditing companies and they agree that these statements regarding the disparity between apparent and actual profits are generally true throughout the machine tool industry, and that the same conditions exist in other industries. I will quote from a letter received by me from the Miller Franklin Co., as follows: 'Your illustration is well taken, but as to whether this 60 per cent you have set is high or low, we would say frankly, taking a number of representative industries into consideration, that it is quite high. . . . Actually, we are inclined to believe that the average manufacturer makes only about 30 or 40 per cent of his expected profit. That is to say, if he counts on a profit of $300 a machine, and at the end of the year has sold one thousand machines, instead of having made $300,000, we generally find that he is fortunate if he has $100,000 which he can pay out in dividends and taxes.'

"I want to impress upon you as manufacturers these facts: that labor costs have not been reduced; material costs have been reduced very little; and the volume of business that you have had is not obtainable now. You should realize that this lack of volume is bound to increase your costs and there are, as yet, no other conditions which will anywhere nearly offset this disadvantage.

"We should maintain an adequate profit in all our business transactions so that we, as manufacturers, may be able to continue our business successfully; be able to remunerate our employes as they deserve; continue to develop the art of machining metal; and pay a fair return on the capital invested."

### Charles F. Lang Urges Industrial Cooperation

The forceful address by Charles F. Lang, president of the Lakewood Engineering Co., Cleveland, Ohio, on the subject of cooperation between manufacturers themselves as well as between employers and employes contained much food for thought, and the optimistic prophecy of Mr. Lang, that the future will see a closer cooperation between capital and labor toward the common end of industrial welfare and prosperity, was one that every manufacturer would like to see fulfilled. Mr. Lang said in part:

"I am one of those who don't want to see the cost of labor come down. The fact is that high wages only exist in good times and low wages are a sure sign of depression.

"America, with her labor the most productive on earth, in splendid financial condition, with the shops of the world empty, and with her own production for ordinary channels curtailed now for five years, is facing a wonderful future; and she will cash in on that future unless the business men of this country start in on cut-throat competition.

"There is another feature in the present situation which is extremely gratifying, and that is the spirit of cooperation between labor and capital, between employer and employe. I hold no brief for the labor unions, but I want to say that if there had been no evils that needed to be righted, if there had been no cause for the organization of labor, there would have been no organized labor; and the time is coming when there will be such cooperation between labor and capital in this country that both capital and labor, I believe, will be organized together for the conquest of the markets of the world for American business. Yet in that conquest we want those same principles of fairness and fair dealing to apply in our foreign commerce which apply in our domestic business.

### Combinations Under the Webb Law

An address was made by Allen Walker, manager of the Foreign Trade Bureau of the Guaranty Trust Co. of New York, on the subject "Combinations Under the Webb Law." In this address, Mr. Walker pointed out the possibilities for combinations of competitive lines to further their foreign trade, and claimed that there was no line of business in which such combinations could not be made to work successfully. He outlined the general principles of organization of such trade combinations as have already been made for the marketing of more general merchandise and staple goods, such as textiles, steel, cement, etc. The foreign trade aspect was also dealt with in some remarks by Robert S. Alter, of the American Tool Works Co., Cincinnati, Ohio, who spoke on the relation between trade combinations of this kind, guided and directed from America, to the native foreign dealers abroad. He advocated cooperation and friendly relations between the new trade combinations and the foreign dealers, as he believed that in this way the best interests of the American machine tool industry would be served and the greatest success of the American trade combinations assured.

### Address on the Bureau of Standards

Dr. Stratton, chief of the Bureau of Standards, Washington, D. C., gave an illustrated lecture on the work of the Bureau of Standards in as far as it affects the manufacturing industries of the country. He pointed out how the bureau is in a position to cooperate with the manufacturers and to solve their specific problems. He asked the manufacturers for their cooperation, and particularly emphasized that they must bring to the bureau their problems so that the scientists engaged in investigating work will know definitely what these problems are, and will be able to work along the lines best calculated to serve real practical industrial purposes. The Bureau of Standards, largely due to its activities during the war, is now equipped with adequate facilities for carrying out investigating work in practically all the varied industries of the country.

# Will Russia Be Ready to Buy in Another Year?

By J. P. T. LUNDIN

Manager of the Petrograd Branch of R. S. Stokvis & Zonen, Ltd.

THE question as to when Russia will again settle down to normal conditions and become a buyer of machine tools and industrial products in general is one which is of the greatest interest to everyone connected with the machine tool business. Present indications point to a very short duration of the Bolshevist regime after which Russia doubtless will soon come back into the society of nations and re-enter into normal trade connections with the rest of the world. In this article it is intended to give a brief review of the present conditions in Russia and to indicate what may be expected in the near future.

**The conditions in Russia are problematical and one guess, perhaps, is as good as another. However, the opinions of a man who has lived in Russia for many years, who speaks the Russian language, and who was in Russia during both the first—the Kerensky revolution—and the second—the Bolsheviki revolution—should be of considerable interest. Mr. Lundin spent eight years in Russia, first as a salesman of machine tools, and later as manager of a well-known machine tool house. He believes that the Bolshevist regime will last but a few months longer and that Russia will be a buyer of machine tools within another nine months, or a year, at most. His description of how the Soviet government attempted to manage industrial enterprises without trained executives is also of the greatest interest.**

### How the Bolsheviki Conducted the Industries

Immediately upon the overthrow of the Czar's government there was a considerable rise in the wages of the workers in all the industries, as well as a shortening of hours. At that time there was still a semblance of industrial order, and manufacturing proceeded in a fairly orderly manner during the Kerensky regime. Manufacturing costs, however, increased greatly. For example, at a conference in Moscow in 1916, locomotives that had been contracted for at $27,500 by the old government, had to be paid for at the rate of $80,000 each by the Kerensky government. As a comparison it may be mentioned that the same locomotives could have been obtained from the United States for $22,500, if proper transportation facilities had been available. The latter price also included a certain number of spare parts, while the prices paid in Russia included no repair parts.

When the Bolsheviki revolution came—caused mainly by the fact that the Kerensky government was too closely tied up with the machinery of the old bureaucracy and, therefore, was powerless to carry out the principles and reforms for which it stood—there was a great upheaval in the whole industrial world of Russia. The Soviet government immediately declared all factories public property. Soldiers' and workmen's councils marched to the factories with orders from the government requesting the former owners, directors, and managers to leave the works at once, as the shops were thenceforth to be run by the Soviet government through its own agencies. The workmen of each plant then proceeded to elect among themselves a committee to run the plant. It appears that the main qualification for executive positions was an ability to read and write, because it was recognized that this knowledge was required for the duties of an executive. As perhaps only ten per cent of the workmen in the mechanical industries can read and write, the choice of executives narrowed down to a comparatively small number of men. In many instances mere boys were placed in executive charge because they were not illiterate. The working day was also shortened to six hours and it was made a criminal offense to work longer. In fact it has been stated that the factories were cleared by military police at the end of six hours to make sure that nobody broke this rule. Six hours of actual work, however, was not the outcome of this arrangement, because such meetings and discussions as were considered necessary in order to run the factory in a thoroughly democratic fashion were held during the working hours.

### First Results of the Soviet Method of Industrial Management

The first difficulty that was met with in this new method of managing an industrial plant was that the shops ran out of raw materials. Nobody, of course, had the foresight to buy or order ahead, as everybody utterly lacked experience in this direction, and when the shops finally ran out of materials, the new managers did not know where to buy. Even if they had known where supplies generally would have been obtainable, it is likely that they would have found that there were no more to be had, because similar conditions obtained throughout all the industrial works in Russia, and the production was cut down enormously. The transportation system was also entirely out of gear, and it was impossible to transport raw materials from one part of Russia to another.

The second difficulty met with was that nobody bought what little there was made in the way of finished products, due, of course, to the fact that all other factories were run by similar managements, who had no knowledge of the channels of trade, and who, although they might need the product of one particular factory, did not know where or how to obtain it. Nevertheless things went along in an apparently smooth fashion as long as the money lasted that the Soviet government had seized when they took over the banks. When food began to become scarce and prices soared, the wages were raised and the working people were kept happy for the time being by high wages and short hours. Later, however, when food became still more scarce, so that money could not buy it, working hours were cut until in some factories the men worked only two hours a day, the excuse for this being that they got so little food that they could not possibly work at manual occupations any longer than that.

### How the Soviet Government Tried to Correct its Mistakes

In due time the men themselves in certain factories, as well as the Soviet government, began to realize that something was wrong, and that they could not get along entirely without the guidance of the men who originally managed the shops. They therefore appealed to the former managers and superintendents, requesting them to come back to run the plants. In practically all cases these men at first refused to have anything to do with the new government and its factories. The workmen's council would then appear before the Soviets and request an order commanding the former management to step in and take charge. Those who refused to return to their old duties at a given hour were threatened with death.

With the old management once more installed, things began to go somewhat better, but as there was no discipline in the shop, nor any means for enforcing the fulfillment of

given orders, the conditions went from bad to worse, and at the present time it is reported from trustworthy sources that the majority of the workmen themselves are dissatisfied with the Soviet government because it has failed to do the one thing that they depended on it to do when they gave it their support—that is, to provide food. If a new government can be established that will overthrow the Bolsheviki, it will doubtless have the support of the majority of the working men, provided it can promise immediate food relief.

As an example of the extremes to which the Soviet management of machine shops in Russia has gone, it may be stated that while at least one of the locomotives mentioned above has been completed at the Poutiloff works in Petrograd, the cost of this locomotive, as reported by the manager of the works himself, is 4,000,000 rubles (which, with normal exchange, is equivalent to $2,000,000). It is evident that any industrial organization where costs mount to such almost unbelievable figures cannot long endure.

### The Great Business Opportunity Open to American Manufacturers when the Soviet Government Passes out of Existence

Men familiar with the present conditions in Russia predict that the life of the present Soviet government is only a matter of months. As soon as a new government is established, probably along the lines of the government of the United States—a republican form of government with a federation of states—Russia will need great quantities of industrial products of all kinds. First of all it will be necessary to put the railroads back in operation, because without proper transportation other industries cannot revive. In the line of machine tools, therefore, the first demand will be for the class of machine tools used in railroad shops and also for bolt, nut, and rivet machinery.

Next in order will come the demand from the machine shops throughout Russia, the equipment of which has run down so that they will probably have to be almost entirely re-equipped. As an example of the conditions in Russian machine shops it may be mentioned that in 1917 the Lisst works in Moscow, manufacturers of pumping machinery, made an investigation into the condition of their equipment and found that about seventy-five per cent needed immediate replacement if the manufacture was to be kept up on an economical basis. This condition doubtless existed practically throughout Russia and was not confined to this plant alone. Two years more of the Bolshevist regime has probably added the other twenty-five per cent to the list that needs replacement, so that it is believed that it is no exaggeration to say that practically every machine shop in Russia needs an entirely new machine tool equipment. In addition, there will be a demand for small tools, screw machine products, piping, boilers, engines, locomotives and cars, rails, and practically everything that is required to build up the industries.

**As soon as a new government is established in Russia, the country will need great quantities of industrial products of all kinds. First of all, it will be necessary to put the railroads back in operation, because without proper transportation other industries cannot revive. In the line of machine tools, therefore, the first demand will be for the class of machines used in railroad shops and also for bolt, nut, and rivet machinery. Next in order will come the demand from the machine shops throughout Russia, the equipment of which has run down so that they will probably have to be almost entirely re-equipped. In addition, there will be a demand for small tools, screw machine products, piping, boilers, engines, locomotives and cars, rails, and practically everything that is required to build up the totally disorganized industries of the country.**

### How New Russia will Handle its Business

Many problems will face the new Russia which is to rise upon the ruins of the Soviet regime. In the first place there will be nothing wherewith to pay for the equipment required. While before the war it was usual to give from three to six months' credit, even to large and important customers, it will be necessary after the war to extend this credit period greatly; but this matter probably will have to be arranged for by agreements between the new Russian government yet to be formed and the great financial institutions of the allied nations. American manufacturers, however, must bear in mind that any trade with Russia within the near future will have to be based upon longer credits, because the first thing the Russian will ask will be: "When must I pay?"

It is doubtful if the native Russian dealers, in general, will be able to take up business at once, although there are a few exceptions to this statement. On the whole, however, their property has been totally confiscated by the Soviet government and they will have no capital with which to begin doing business on a large scale. Foreign dealers will probably obtain the greater part of the business and will carry it on with foreign capital. The Scandinavian and Dutch dealers may be expected to be especially active.

### How the American Machine Tool Manufacturers may Obtain their Share in the New Russian Trade

The large American machine tool manufacturers should send their own men over to study the conditions in Russia just as soon as a new government is established and it is possible to travel safely in the country. Of course, if the American manufacturer is already represented by well-known dealers in Russia, such first-hand investigation may be unnecessary; but if not represented, the best and safest method would be to make a first-hand investigation and then select a dealer who is capable of handling the business in Russia and who is established in such a way as to meet the Russian requirements.

In traveling in Russia, the American investigator must understand that he cannot expect to do much, if any, immediate selling. Machinery is not sold in Russia in the same way as it is in America, England, or France. In fact, you cannot talk business with a man upon your first call to his office. You must first get acquainted, and later the subject of business may be introduced. To secure results in the Russian market, therefore, it is absolutely necessary to be represented by a dealer who is fully familiar with Russian customs and conditions, and only a native house, or a house that has a permanent well-established branch in Russia can fulfill this function.

### Conclusion

Summing up, the writer believes that the present Soviet government will be overthrown shortly, because it has failed to keep its promises to the Russian people, and all classes appear to be dissatisfied with it. The new Russia, built upon the ruins of Czardom, will rise quickly. Thousands of educated men left Russia after the Bolshevik revolution, and these men have since been living in Western Europe and the United States. When a new government is established in Russia, they will return and will bring with them many ideas which will aid in accelerating the development of Russia. Their exile may prove one of the greatest benefits to Russia during her reconstruction period, and the rapid rehabilitation of Russian industries will be greatly aided by the observations made and the knowledge obtained by those men while abroad.

* * *

## CINCINNATI BRANCH OF AMERICAN STEEL TREATERS' SOCIETY

The American Steel Treaters' Society, with headquarters in Chicago, Ill., has organized a branch in Cincinnati, Ohio. W. S. Spear, metallurgist for the Cincinnati Milling Machine Co., was elected chairman, and J. M. Manley, secretary of the National Metal Trades Association, was elected secretary-treasurer. All applications for membership in the Cincinnati branch should be addressed to J. M. Manley, secretary, 705 Elm St., Cincinnati, Ohio.

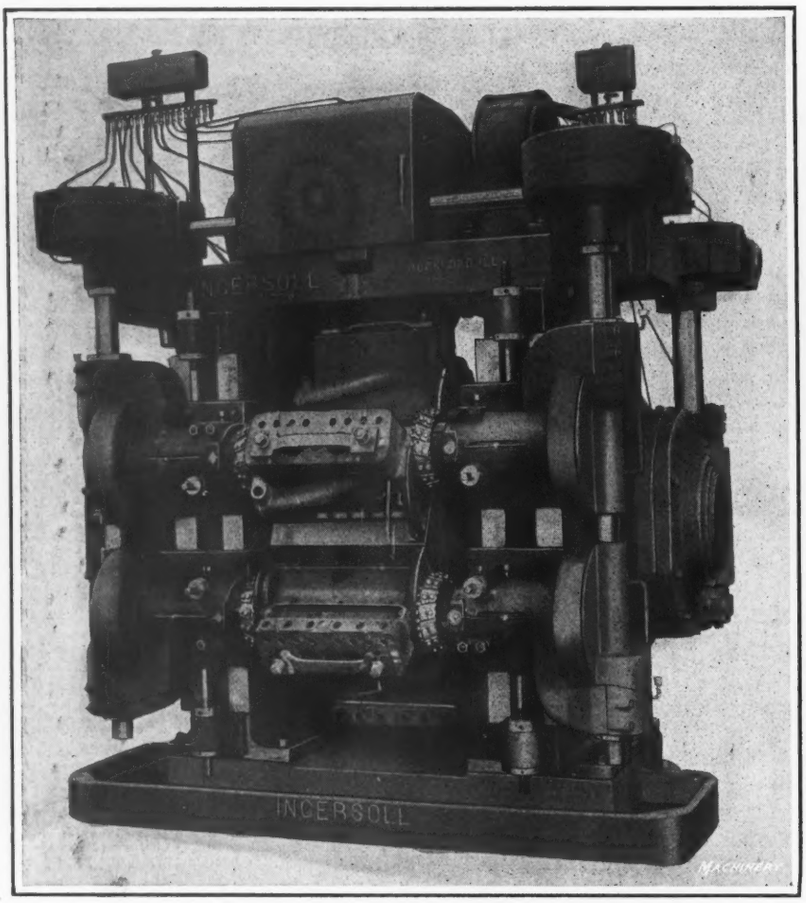



Fig. 1. Ingersoll Machine of Continuous Rotary Type milling Ends of Tractor Cylinders

## MILLING TRACTOR CYLINDERS ON CONTINUOUS TYPE MACHINE

At the plant of Henry Ford & Son, Dearborn, Mich., the ends of tractor cylinder castings are milled on a special machine of the rotary continuous type, built by the Ingersoll Milling Machine Co., Rockford, Ill. This machine is arranged to take both roughing and finishing cuts, and a milled casting is removed from the machine and replaced by a rough one every two minutes. This rate of production is possible because there is no idle or non-productive period, the castings passing continuously between the opposed roughing and finishing cutters. Owing to the efficiency of the continuous rotary milling machine, and to the increasing use of this general type for large-quantity production, special articles on the rotary milling process have been published in recent numbers of MACHINERY (see the April number, page 687, and the May number, page 842), and the example of rotary milling shown by the accompanying illustrations is intended to supplement the articles referred to, since the operation and the special machine employed are of unusual interest.

Fig. 1 shows a front view of the machine, and Fig. 2 a rear view. The castings seen lying at the base of the machine in Fig. 2 are milled on this machine. These castings are held on a large drum, which has six work-holding positions. The machine has four cutter-spindles, with the cutters arranged as clearly shown in Fig. 1. The upper pair of cutters is for roughing, and the lower pair for finishing. As the drum revolves, the castings are traversed down toward the machine base, as seen from the front, the roughing and finishing cuts following successively. As each finished cylinder comes up at the back of the machine, it is removed and replaced by a rough cylinder. The rough and finished castings are brought to and carried away from the machine by means of a belt conveyor. The work-holding drum makes a complete revolution every twelve minutes, which gives a cutting speed of approximately 11½ inches per minute. These cylinders are said to be finished flat and parallel within 0.002 inch. The extreme dimensions of the areas covered by the milling cutters are 15 5/8 by 9 1/32 inches at one end of the cylinders and 19 9/16 by 9 9/16 inches at the other end of the cylinders.

The motor is mounted on top of the machine, as shown by the rear view. The axle which carries the work-holding drum is supported by housings of box construction, and it is driven at each end by means of two large bronze worm-wheels, 29 inches in diameter. The main driving shafts are 5 inches in diameter, and other shafts and all important parts are made heavy and unyielding to secure the necessary rigidity for the machine and accuracy in the product. All gearing is carefully guarded, and there is no overhang on any of the bearings. The system of lubrication is shown in part by the illustrations. The bearings throughout are oiled automatically from sight-feed oilers, and all gearing runs in oil. This machine is 10 feet high and weighs about 41,000 pounds. While the machine was constructed especially for the particular milling operation mentioned, it is possible to adapt it to other work by changing the drum. It was considered more desirable to build a high-production machine adapted for a single job than to attempt to make a universal machine.

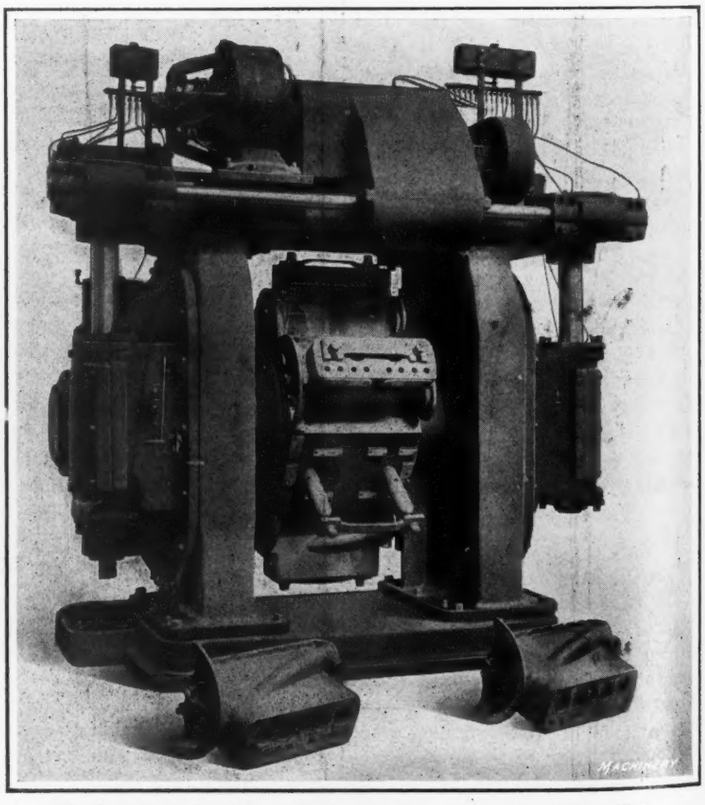


Fig. 2. Rear View of Rotary Milling Machine, and Castings being milled

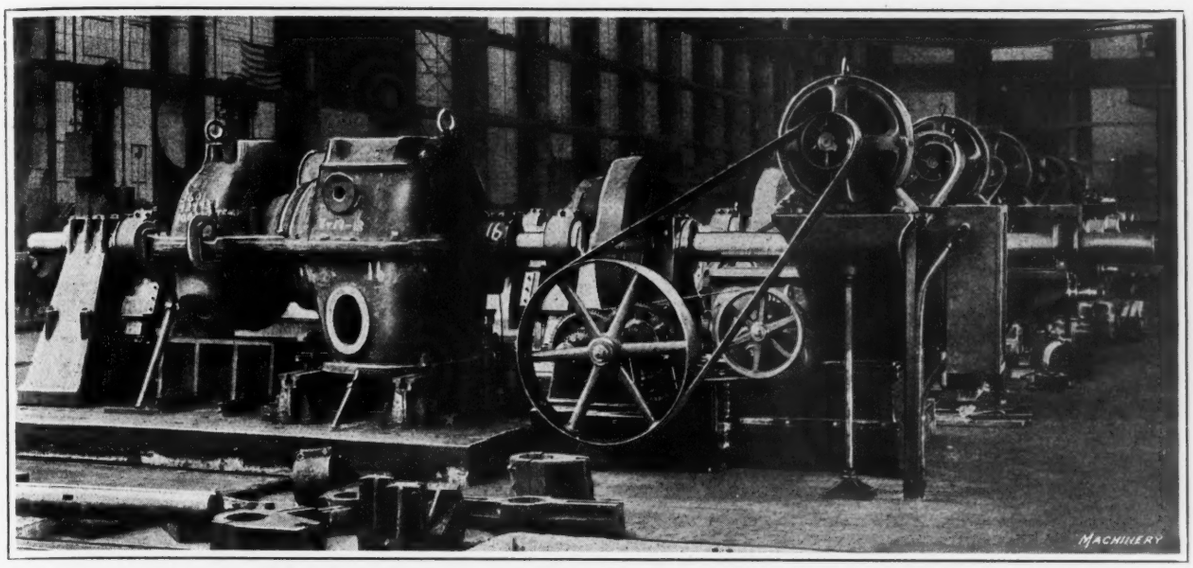


Fig. 17. A Battery of Special Horizontal Boring Machines designed for Use in machining Marine Turbine Cylinder Castings

# Building the Westinghouse Marine System

## Second of Two Articles Descriptive of the Manufacturing Equipment of the New Westinghouse Plant at South Philadelphia, Pa., and Some of the Machining Operations Involved in the Making of the Westinghouse Marine System

BY EDWARD K. HAMMOND

REFERENCE was made in the first installment of this article to the turbine cylinder in which blades are mounted corresponding to the blades set in the rotor. The cylinder is made of a gray iron casting, and the first step in machining is to set the work up on a planer on which all finished surfaces are planed. The work is next transferred to a radial drilling machine, as shown in Fig. 19, on which holes are drilled in the joints ready to receive bolts which hold the two halves of the cylinder together; also, a hole is drilled and tapped for an eyebolt, which provides for lifting the casting. The joints are next scraped to an accurate fit, after which dowel-pins are put in place and the two halves of the cylinder casting are bolted together. The work is then taken to a boring machine on which it is set up (see Fig. 17) to have the spindle bearings rough-bored.

The next step is to finish the tapped holes accurately to size with a hand sizing tap, finish-counterbore the bolt holes to have the bottoms of the counterbores at accurate right angles to the holes, and carefully ream the dowel-pin holes. Use has already been made of bolts and dowel-pins inserted into these holes, but this was merely to secure the two halves of the work together for rough-boring the spindle bearings, so that exact precision of the fit had no significance. The joint between the upper and lower halves of the cylinder is next carefully scraped, after which the dowel-pins are fitted into their reamed holes. When this work has been finished, the two halves of the cylinder are again bolted together and the entire cylinder is carefully finish-bored and grooved, the operation being performed on a horizontal boring machine. The grooving tool used for this purpose is carried in a boring-bar through which a feed-rod slides in an axial hole. This feed-rod carries a tapered shoe at its forward end, which engages a corresponding tapered surface on the top to provide for feeding this tool out into the work. Movement of the feed-rod through the boring-bar is accomplished by means of a wheel fitted onto the threaded end of the rod at the rear end of the boring-bar. The final operation performed in the machine shop is to lay out the positions of the holes for bolts used in securing the nozzle block chamber to the cylinder, to lay out the vertical and horizontal oil-holes, and to lay out the exhaust connections. After these holes have been drilled the cylinder is sent to the erecting shop where the blades are put in.

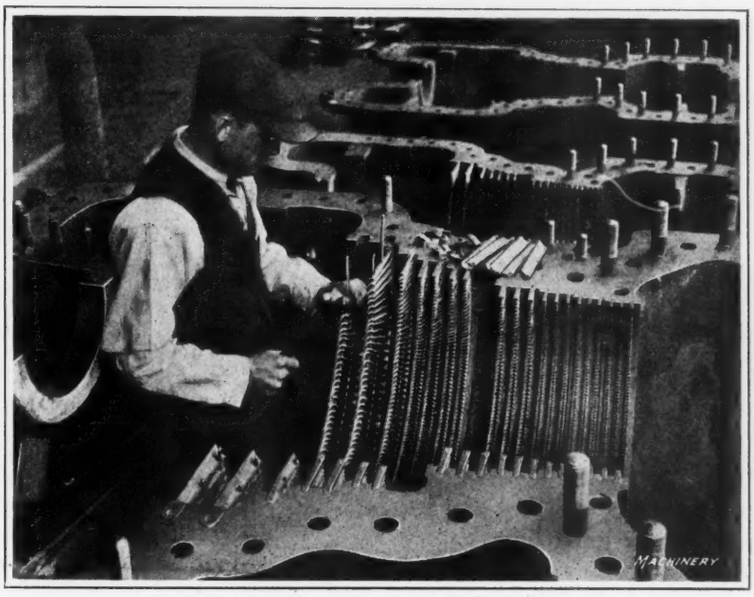


Fig. 18. Assembling the Blades in a Turbine Cylinder. This Illustration clearly shows the Stay-wires which help to support the Blades

### Setting Blades in Turbine Rotors and Cylinders

In connection with the explanation given in the first installment, of the way that machining operations are performed on the turbine spindle, mention was made of the tapered or dovetailed form of the blade grooves. The reason

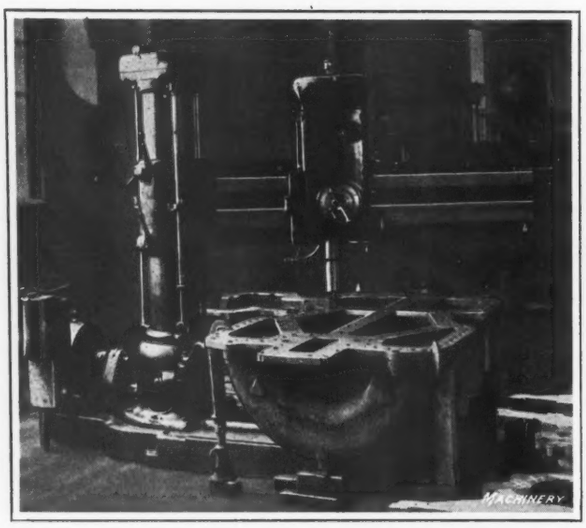


Fig. 19. Drilling Bolt Holes in Top Half of Turbine Cylinder Cover

for this form of the grooves is that the steel spacers or packings which fit in the grooves between each pair of adjacent blades are tapered on the sides so that they cannot rise vertically out of the grooves. These spacers or packings rest on a head swaged on the bottom of each blade, thus holding the blades securely down in the grooves. The packings are made of cold-rolled steel and the blades are made of copper. The method of procedure in manufacturing blades is briefly as follows: Copper sections are rolled to the required cross-section and then reduced to exactly the proper size, and also given a good finish, by being drawn twice through drawing dies. After the head has been swaged on the end, two comma (,) shaped holes for the stay-wires are pierced under a power press, after which the finished blade is cut off.

In assembling blades into either the rotor or cylinder of a Westinghouse steam turbine, the first step is to secure what is known as a "start-piece" into one of the grooves, after which alternate blades and spacers are inserted until the groove has been filled all of the way around ready to receive the final insert which is known as "stop-piece." The operation of assembling the blades in the cylinder is illustrated in Fig. 18. Each blade, made to set at right angles, is pierced with two holes, a round hole in the center and a comma-shaped one near the end. The round stay-wire which passes through the center hole gives greater strength and stability, and the comma-shaped wire which passes through the comma-shaped hole keeps the blade from twisting when it is under steam pressure, and also forms a strut between the blades.

After a blade has been set in place and measured by a 90-degree gage, the stay-wires are bent on each side of the blade to hold it in the proper position. When a row is completed, the spacing between the blades is again tested by a feeler gage which is designed to snugly fit in the standard passage for steam. All deviations are corrected. The next step is to weld the stay-wires to each of the blades. This is done with an oxy-acetylene torch and wire of special composition, as shown in Fig. 20. After the blades in all of the grooves have been welded to the stay-wires, the cylinder or rotor is taken to a boring machine or to a lathe, as the case may be, and set up ready to have the blades of the cylinder bored or the blades of the rotor turned to the required diameter. Fig. 21 shows the operation of turning the blades of a rotor down to the required diameter in a lathe.

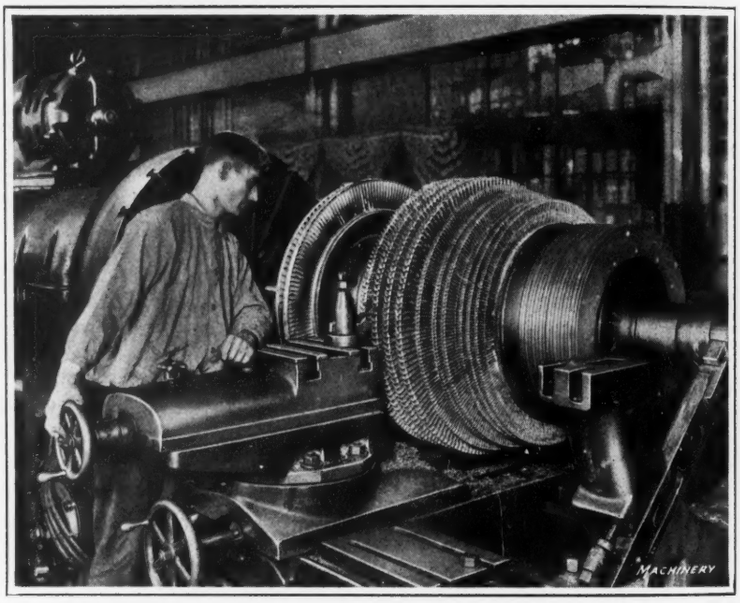


Fig. 21. Turning the Blades of a Turbine Rotor down to the Required Diameter

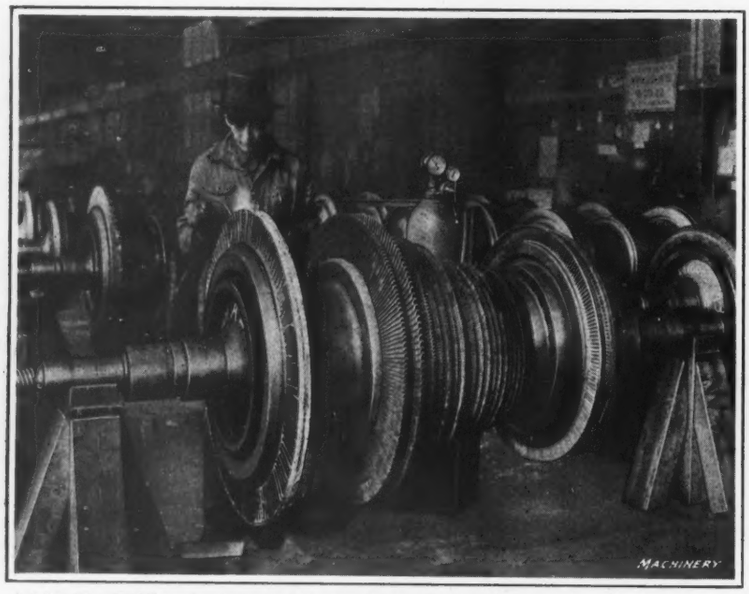


Fig. 20. Welding the Stay-wires to the Blades with an Oxy-acetylene Torch. This prevents Danger of the Blades slipping on the Stay-wires

### Importance of Balancing Turbine Rotors

Accurate balance of the rotors of marine turbines is a matter of absolute importance, because they run at approximately 3600 revolutions per minute, and any lack of balance would result in serious vibration and an abnormally rapid wear of bearings and other parts. To avoid trouble from this cause, a practice is made at the plant of the Westinghouse Electric & Mfg. Co. of very accurately balancing the rotors. In handling this work, use is made of the principle that where all parts of an assembled rotating member are in accurate balance, the entire member will also be accurately balanced. The advantage of balancing separate parts of the assembly independently is merely one of the greater convenience of handling the work. In starting the work of balancing turbine rotors after insertion of the blades has been completed, the bolts which secure the end piece to the drum are removed and a connection is made with a tapped hole in the side of the turbine rotor to provide for filling the rotor with

water and then applying hydraulic pressure to force the end piece out of the drum. When this has been done, each of the end pieces and the drum are balanced independently on a special static balancing machine, the design and use of which were described in detail in an article entitled "Dynamic and Static Balancing," published in the December and January numbers of MACHINERY. This machine was illustrated in Fig. 19 of the article to which reference is made. After the separate parts of the rotor have been balanced in this way, the spindle is reassembled and again tested for static balance on the commonly used form of knife-edge ways. It will seldom be found that there is any lack of balance of the assembled member after each of its parts have been independently balanced; but should any error be discovered, it must be absolutely corrected before the rotor is assembled into a complete turbine.

### Drilling Condenser Tube-plates

For use in connection with marine turbine systems of its manufacture, the Westinghouse Electric & Mfg. Co. makes surface condensers, one of which is shown in Fig. 23 with the end plate removed in order to show the design more

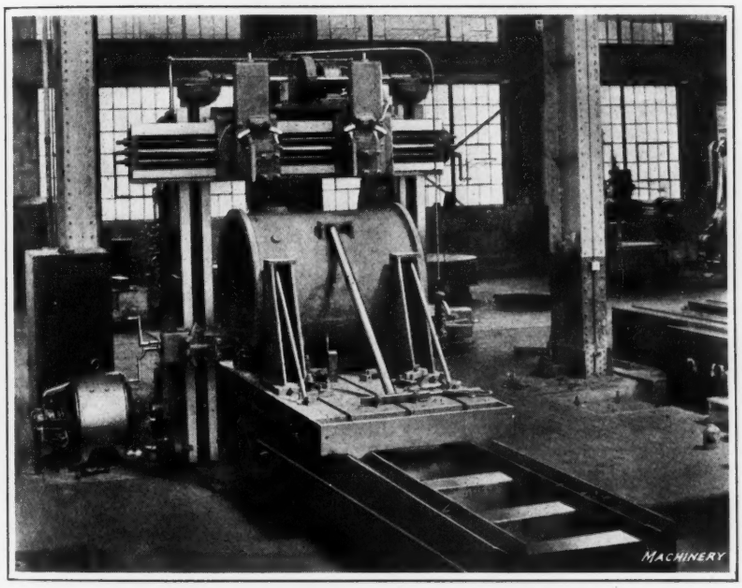



Fig. 22. Planing the Shell Casting for a Condenser

clearly. One of the interesting operations in machining parts of these condensers is the drilling of the tube-plates. These plates are laid off and then drilled on radial drilling machines. In each condenser there is one cast-iron supporting plate at the center and two Muntz metal plates, one at each end. An ingenious method has been worked out by which a plate which has already been drilled and counterbored is used as a jig for the performance of subsequent drilling operations. By this plan, a drilled and counterbored plate is laid on top of two plates which are to be drilled and the three are clamped together. The top plate with the counterbored holes is fitted with hardened steel bushings through which the drill passes without any friction and drills the holes in the two lower plates. This arrangement saves labor in the lay-out of the work and insures accuracy and good workmanship.

### Assembling Condensers

The condenser shells are made of gray iron castings, and the first step in machining them is to plane the joints as shown in Fig. 22, after which the bolt holes are drilled and reamed. Then the joints are scraped to an accurate fit. Before putting the tubes in place, the condenser shell is completely assembled and filled with water, which is then subjected to pressure in order to ascertain that there are no defects in the casting or workmanship of fitting the

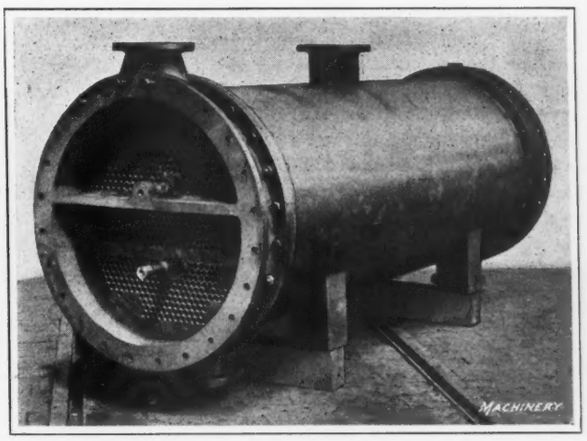



Fig. 23. Westinghouse Marine Condenser with End Plate removed to show Arrangement of Tubes

joints. After this has been done the cast-iron tube support is put in at the center of the shell and the Muntz metal tube plates at either end, after which the work of assembling may be started. The brass tubes are shipped to the plant, cut to exactly the required length, and the first step is to assemble these in place in the condenser plates. Then the space between the tubes and end plate has to be securely packed. For this purpose a piece of string, commercially known as corset lace, is cut to a length of twenty-six inches which is just enough to pack the space. A special calking tool, made of steel tubing, just the size to enter the counterbored holes is used to feed and pack the string. The end of the string is put into the space between the tubes and plate, and the calking tool is then pushed into position. Light taps on this tool, with a rawhide mallet and a turn of the tool feeds the string which securely packs the tubes into position. A threaded ferrule is then screwed into the hole over the packing which forms an effective seal. A view in the shop, showing girls engaged in calking the tubes into the tube-plates of the condensers may be seen in Fig. 27. After packing the tube joints, the water chamber and end plates are assembled in place, and the entire condenser is given a second water test under pressure. When this test shows that there are no defects, the water is drained out and the condenser painted for shipment.

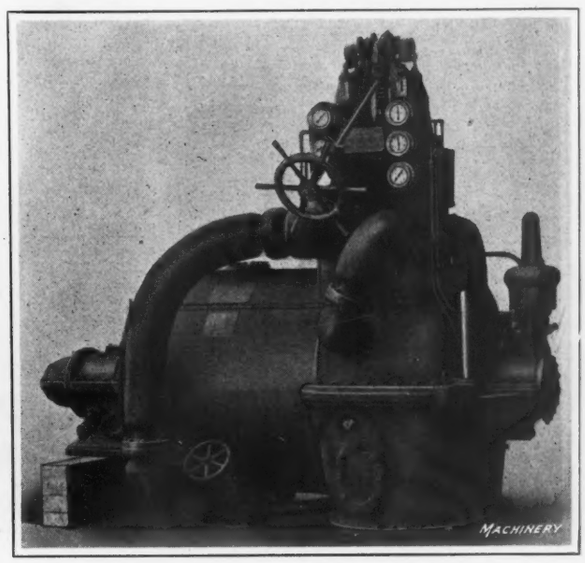



Fig. 24. Assembled Turbine Equipment Ready for Shipment

### Testing the Completed Turbine

After the erecting department has assembled all parts of a turbine, there is still some highly important work to be done before the completed unit, a view of which is shown in Fig. 24, is ready for shipment. This consists of giving the turbine a running test, as shown in Fig. 28, during which time it is under the observation of an experienced operating engineer who definitely ascertains that all members of the equipment are functioning properly and directs the making of such adjustments as are necessary in order to enable the turbine to operate at maximum efficiency. After a turbine has been set up on the test blocks and connected to the steam line, the first step is to carefully examine all oil-cups and channels, to make sure that there is no obstruction which would prevent the free circulation of lubricating oil. Next the turbine spindle is turned over very slowly and great care is taken to see that none of the blades on the rotor interfere with blades mounted in the cylinder. Similar precautions are taken to assure that all other parts run freely. When these preliminary steps have been taken, steam is admitted into the turbine cylinder and the machine is allowed to run, first at a very low speed. After being allowed sufficient time to warm up under these conditions of operation, the turbine is gradually speeded up until the normal speed of 3600 revolutions per minute is reached, and this condition of operation is maintained for a sufficient length of time to show definitely that the equipment runs smoothly and without tendency for the bearings to become heated or other objectionable conditions to manifest themselves. Finally, the turbine is run at 50 per cent in excess of the normal speed, that is, at 5400 revolutions per minute for a short period of time.

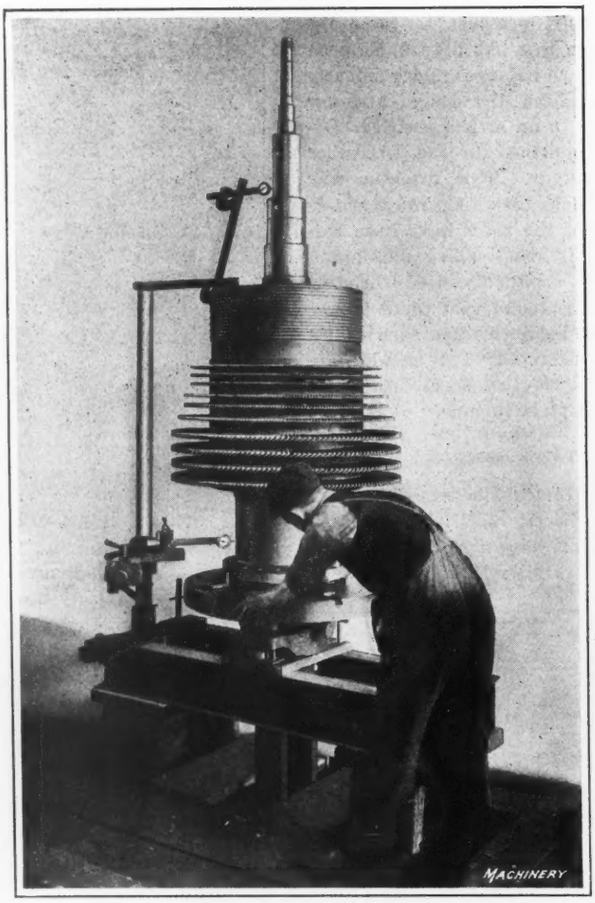



Fig. 25. Balancing the Assembled Turbine Rotor

### Assurance of Satisfactory Results from Westinghouse Marine Systems

This care which is taken in testing the operation of Westinghouse marine turbines (and the same is in every way true of tests made of reduction gears, which have been described in the preceding installment of this article) is typical of the precautions that are observed in performing each operation in the process of manufacturing all parts which enter the completed equipment, in order to be absolutely sure of perfection of the finished product. The greatest care is taken in the selection of all materials, and an idea has been given of the way in which the chemical and physical laboratories check up the quality of these materials when they are received at the plant, in order to provide against the possibility of inferior grades of metal being shipped from the mills as a result of an error. The same degree of care is observed all of the way through the process of manufacture. Men are carefully trained to perform each important machining operation, and they are instructed in the use of gages and methods of testing to assure that the required degree of accuracy and perfection of workmanship have been obtained.

An important factor in assuring the attainment of perfect workmanship is the excellent equipment of high-grade machine tools of the very latest types with which the plant is equipped—tools which can be depended upon to produce work of the highest perfection of finish and of the greatest possible accuracy. These machines are used in a plant which was completely laid out by efficiency engineers of

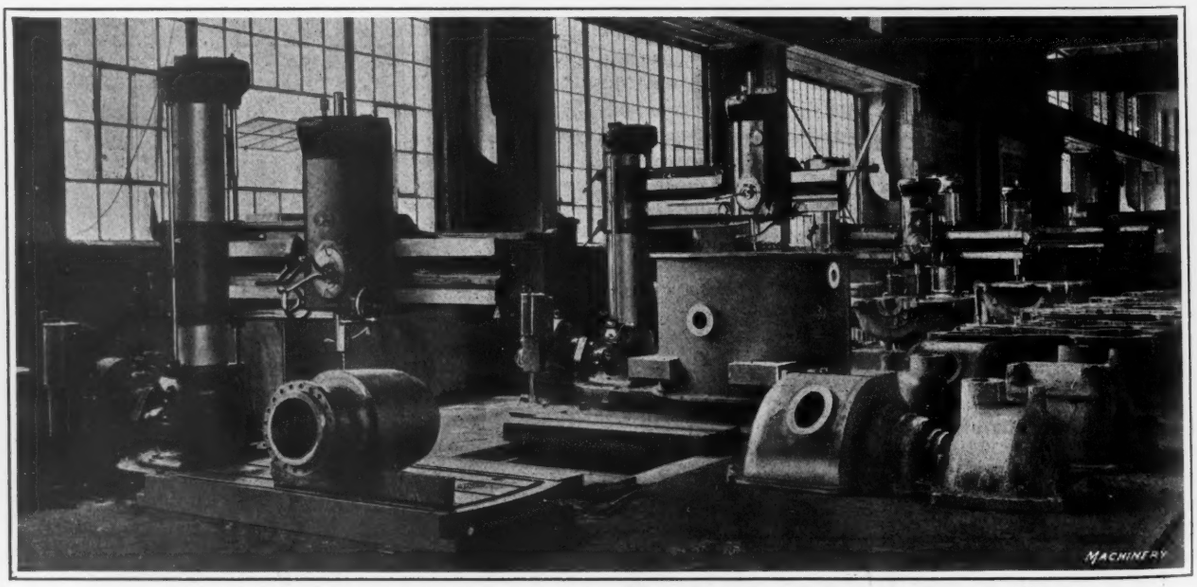



Fig. 26. Machining Operations performed on Marine Turbine and Condenser Parts in Machine Shop No. 1

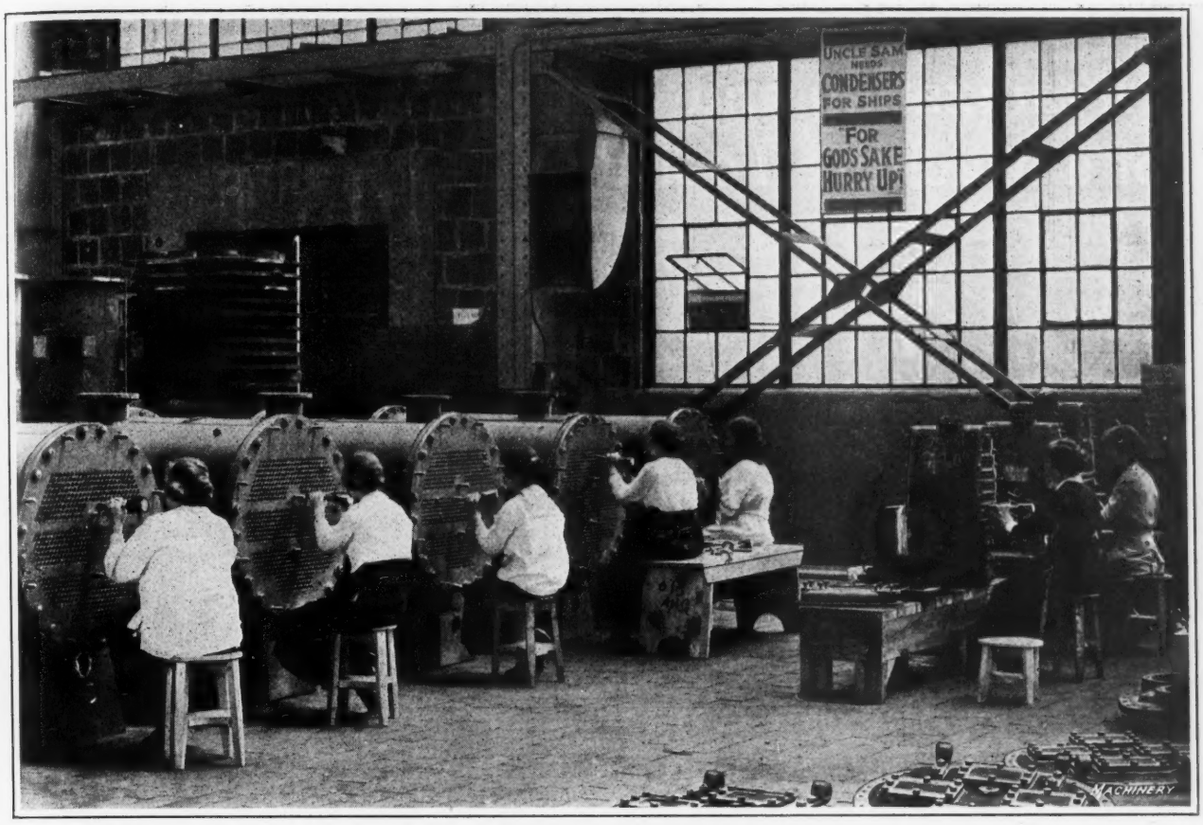



Fig. 27. Calking the Tubes into Tube-plates of the Condensers

wide experience before construction was started. Naturally, this was the means of enabling ideal conditions of operation to be attained. By laying out the entire plant for operation upon a carefully arranged plan, all departments are located in the proper relation to each other, which is an important matter in handling raw materials and parts in course of production. It is all of these factors, combined with a progressive and aggressive system of management, which has enabled the Westinghouse Electric & Mfg. Co. to turn out the remarkable number of completed marine systems which have been finished in the short period of time during which the new plant has been in operation.

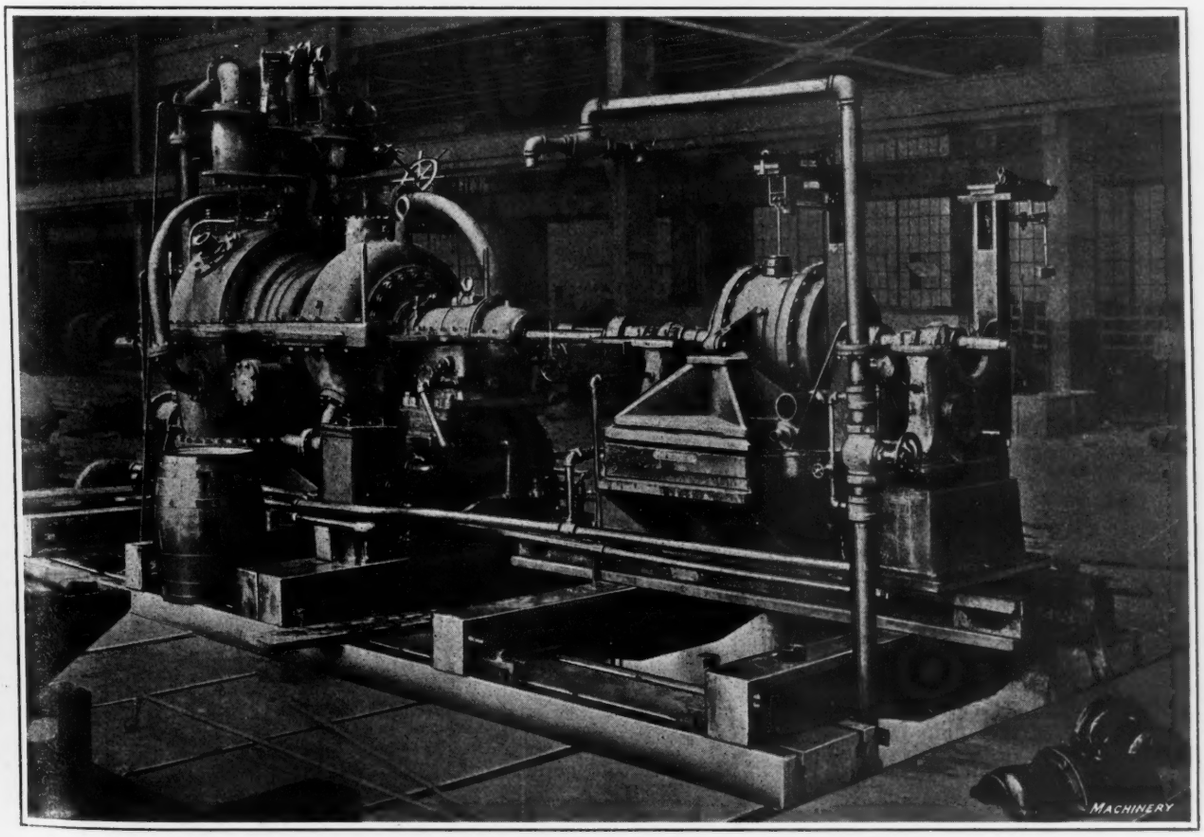
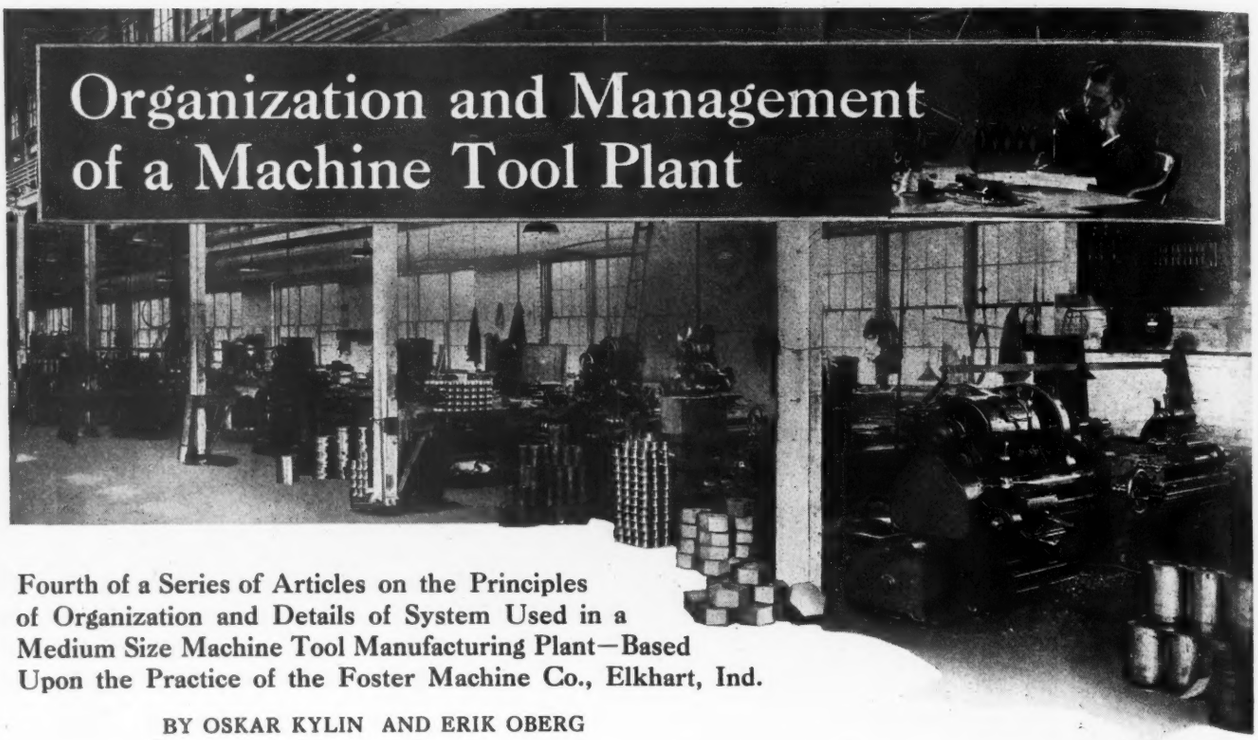



Fig. 28. Turbine Equipment set up on Testing Blocks to receive a Trial Run before being shipped

# Organization and Management of a Machine Tool Plant



**Fourth of a Series of Articles on the Principles of Organization and Details of System Used in a Medium Size Machine Tool Manufacturing Plant—Based Upon the Practice of the Foster Machine Co., Elkhart, Ind.**

BY OSKAR KYLIN AND ERIK OBERG

THE previous installments of this series of articles have dealt, respectively, with the general functions of management and with the methods and systems used by the Foster Machine Co., in its engineering department and manufacturing department, giving details relating to the work carried on by the planning department, the tool-room, the routing department, etc. The present and last installment of the series will deal with the factory control; that is, the methods employed for keeping the management constantly informed upon the performance of the factory so that there is at all times proper data in the hands of the managing board relative to the efficiency of the plant. A brief review of the work of the advertising and employment departments, and of the general principles applied to the handling of men in a machine tool plant is included.

### Factory Control

Fig. 38 shows at *A* and *B* two diagrams which indicate the inter-relations underlying the important principles of the control of the factory by the management. At *A* is shown how the manufacturing schedule is determined by reference, on the one hand, to the standard time for each operation and, on the other hand, to the total capacity of each department. From the standard time for each operation, the total number of hours required per department for a given lot of machines can be determined. It is evident that, when the total number of hours required for a given lot of machines is divided, say, by the total capacity of a department expressed in hours per month, the quotient will be the number of months required for passing through a certain number of machines, and in this way the manufacturing schedule, which indicates the time required for the manufacture of the product, may be made up.

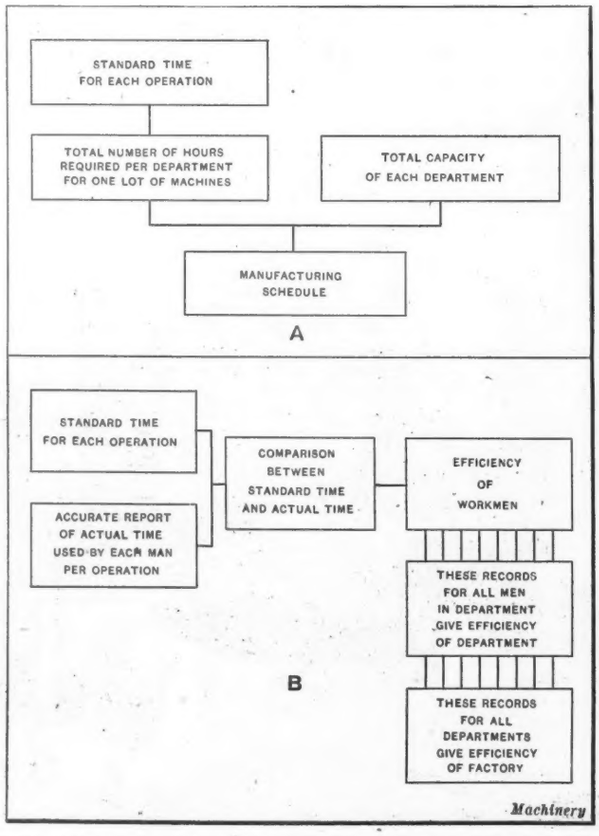

STANDARD TIME FOR EACH OPERATION
TOTAL NUMBER OF HOURS REQUIRED PER DEPARTMENT FOR ONE LOT OF MACHINES
TOTAL CAPACITY OF EACH DEPARTMENT
MANUFACTURING SCHEDULE
A
STANDARD TIME FOR EACH OPERATION
ACCURATE REPORT OF ACTUAL TIME USED BY EACH MAN PER OPERATION
COMPARISON BETWEEN STANDARD TIME AND ACTUAL TIME
EFFICIENCY OF WORKMEN
THESE RECORDS FOR ALL MEN IN DEPARTMENT GIVE EFFICIENCY OF DEPARTMENT
THESE RECORDS FOR ALL DEPARTMENTS GIVE EFFICIENCY OF FACTORY
B
Machinery

Fig. 38. Diagram showing the Inter-relation of Information upon which the Factory Control of the Foster Machine Co. is based

In the diagram *B*, is indicated how the efficiency of the plant may be recorded. By comparing the standard time for each operation with an accurate report of the actual time used by each individual man for this operation, a comparison between standard time and actual time can be made. This comparison, in turn, gives a key to the efficiency of each individual workman, and the records of efficiency for each man, when taken together, form a record of the efficiency of the department. The efficiencies of the various departments, when summed up, give a record of the efficiency of the whole factory. The following paragraphs will explain how these principles are applied in the practical control of the factory of the Foster Machine Co.

### Departmental Efficiency Records

It is highly important that there be a record of the efficiency of each man and of each department, because weaknesses in a department may be indicated in this way, and thus it is possible for the management to know which men give satisfactory service. These records show also the value of new ideas and improvements, so that it is possible to find, in plain figures, the value of innovations. Hence, the records make it

possible to improve manufacturing conditions in many directions, and they also give an idea as to promotions and increases in pay, and furnish other information that the management should have with regard to the men. Fig. 39 shows the record of the men in a certain department, and gives a comparison of the standard production hours and the actual time required by the different men for performing their work. The total hours at the bottom of the card give an idea of the efficiency of the department. These records cover periods of two weeks, and are used by the department foremen and the superintendent to give them the information that they require relating to the men and to the departments.

### Progress Reports

Fig. 40 shows another report that is prepared for two weeks at a time, the object of this report being to provide a record which will show how nearly completed a job is in the shop at any given time. The job numbers are given at the top of the columns and under each job number two columns are provided, one headed "Time Allowed" and one, "Time Consumed." The time allowed is the total time required for the job, based upon standard time for each operation. The time consumed gives the number of hours that have actually been employed in completing part of the job. By comparing the two values, it is possible to determine approximately the percentage of the completion of a job. If, for some reason, the manufacturing schedule should need revision, the record, Fig. 40, makes it possible to change the schedule in an intelligent manner and without guesswork. The report will show also if certain work can be accelerated beyond schedule time, as may be necessary in case an order comes in for a machine to be completed ahead of the schedule. It will be noted that, in all cases, these control records have the standard time as a basis of comparison. No control is possible, unless there is a standard of comparison by which performance may be compared. Hence, in every case where the management aims at efficiency, it is necessary to establish as nearly as possible a "standard of performance," and then see that this standard is lived up to.

Fig. 41, which is a repetition of the part list with an extension for recording costs, is a control record of the efficiency of the whole factory. This record shows actual costs, and when these costs are compared with the standard costs, the percentage of efficiency of the entire factory may be established. This record is of the greatest importance in the economical handling of factory production. Under the heading "Labor" the labor costs for each operation on each piece are recorded, and these added together give the total labor cost. The total labor cost added to the cost of materials and the overhead cost gives the total manufacturing cost for each piece. This record is simple and yet gives all the information that is required by the managing board or the president of the concern for determining whether costs are rising or falling, and makes it possible to determine easily the causes for increased cost so that, if possible, these causes may be removed.

DEPARTMENT: Screw Machine FROM Oct. 7 TO Oct. 21 1918

| NAME | MACHINE | STANDARD PRODU'T'N, HOURS | ACTUAL TIME, HOURS | IDLE TIME, HOURS |
|---|---|---|---|---|
| Sam Smith | No. 5 Screw Mach. | 105 | 110 | — |
| Chas. Jones. | No. 2B Turret Lathe | 112 | 110 | — |
| H. Brown | No. 3B Screw Mach. | 87 | 108 | — |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | TOTAL | 304 | 328 | |

Machinery

Fig. 39. Record of Efficiency of Men in a Certain Department

M-140 1-B U.T.L. Pointed Tool JOB NO._____ NO. M'CH'S_____ E-13072

| NO. OF PIECES ON JOB | NO. OF PIECES ON UNIT | NAME | PART NO. | B.P. NO. | MATERIAL | DIAM. | LENGTH | STOCK | REMARKS | LABOR: OPERATION NO. 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | LABOR: TOTAL | MAT'L COST | O.H. COST | TOTAL MFG. COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | Screws | 281C | 231C | | 1/2 | 2 5/8 | | | | | | | | | | | | | | | | | | |
| | 2 | Washers | 1107 | 1107 | A-1-S | 1 1/4 | 1/4 | | | | | | | | | | | | | | | | | | |
| | 2 | Screws | 12376 | F12403 | A-1-S | 13/16 | 2 7/8 | | | | | | | | | | | | | | | | | | |
| | 2 | Roll Jaws | P12793 | F12824 | M.I. | | | | | | | | | | | | | | | | | | | | |
| | 2 | Studs | 12794 | F12827 | A-6-S | 5/8 | 1 5/16 | | | | | | | | | | | | | | | | | | |
| | 2 | Rolls | 12795 | F12828 | A-6-S | 1 5/16 | 5/8 | | | | | | | | | | | | | | | | | | |

Fig. 41. Part List with Extension for recording Costs, providing a Record of the Efficiency of the Entire Factory

### Advertising Department

The advertising department is organized under the engineering department, because intelligent advertising work of a line of machinery such as machine tools cannot be conducted by any other department in a thoroughly efficient manner. The advertising of machine tools consists principally of conducting an educational campaign, and the advertising must convey definite engineering information regarding the product. It must state what the product can do in regard to economical manufacture, and no other department could give as accurate and essential information on this subject as the engineering department. This is especially true in the writing of catalogues and circulars, as these should be more than mere records of dimensions and general statements. Trade journal advertising now also gives more definite information than in the past, and all advertising literature, whether in the form of catalogues, circulars, or trade journal advertising, to be of the greatest value, should consist of brief, technical descriptions of the products. While the engineering department, therefore, should have charge of the advertising, because it knows what the product is designed to do and what can be

WORK PROGRESS REPORT Date_____

| DEPARTMENT | JOB NO. | | JOB NO. | | JOB NO. | | JOB NO. | | JOB NO. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | TIME ALLOWED | TIME CONSUMED | TIME ALLOWED | TIME CONSUMED | TIME ALLOWED | TIME CONSUMED | TIME ALLOWED | TIME CONSUMED | TIME ALLOWED | TIME CONSUMED |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Fig. 40. Progress Report, providing a Record showing how nearly a Job is completed in the Shop at Any Given Time

obtained from the machine in the way of performance, it is evident that the engineering department should work in close cooperation with the sales department in preparing advertising material and in formulating advertising policies. It is evident, of course, that the general policies are determined upon by the managing board, so that the engineering department has charge merely of the execution of the policy that has been formulated.

### Employment Department

The importance of the employment department is becoming more and more recognized. The idea that every foreman can hire his own men and that efficiency and satisfaction can thereby be obtained is passing away. The superintendent's time should be occupied with production problems and not with interviewing applicants for positions. Hence, he should not be requested to devote his time to hiring labor. A special employment department with an employment manager should take care of this part of the work, and the employment department should, in addition to hiring labor, become a link between the employe and the employer after the men have been hired. If this feature of the work is properly conducted, the employment department can aid greatly in promoting good will and cooperation between the firm and the men, to the best interests of both the employes and the company. In Fig. 42 may be seen the form of application blank used.

FOSTER MACHINE COMPANY

APPLICATION

Name ..... Age .....
Street Address ..... Phone .....
City ..... State .....
Married ..... Children ..... Nationality .....
Are you an American Citizen? .....
Where Last Employed .....
Length of Time Employed ..... Wages Received .....
Reason for Leaving .....
Occupation .....
Kind of Position Wanted .....
.....
..... Wages Expected .....

(Do not write below this line.)

Date Employed ..... Clock Number .....
Occupation ..... Rate .....
Signed ..... Approved .....
Foreman. Superintendent.

Fig. 42. Application Blank for Employment

Fig. 43 shows a record of increases in pay, as well as a record of men leaving the employ of the company. Fig. 44 is a special record kept by the employment department, giving confidential information relating to the personality, character, etc., of the employes. In filling out these records, four grades of rating are used: Very good; good; fair; and poor. This record makes it possible for the management at any time to obtain a fair idea as to the personality and qualifications of the men in the company's employ, and is of value when questions of promotion, raises in pay, etc., have to be decided.

### General Principles Relating to the Handling of Men

A fundamental principle in the handling of men at the Foster Machine Co. is that the foreman should be more of a teacher than a boss. In fact, this is insisted upon as one of the most important principles of proper management, and this principle should be applied right at the top and should permeate throughout the whole organization. The principal duty of the foreman is not to do a great deal of work himself, but to see that the men working in his department are aided in obtaining the production which the system and facilities provided make it possible to obtain. He must not be a driver, however, but a leader. He should keep the men in his department working at full efficiency, but should not make an attempt to force the worker beyond the normal capacity of endurance. Men can work at a certain per cent of overload just as machines can—for a while; but the maximum production in the long run becomes the greatest when the men work at full normal efficiency, rather than at an overload capacity.

It is a great mistake to enforce non-essential authority. There is nothing to be gained in trying to get a man to do a certain thing that is non-essential, simply because the foreman has the authority to make a man do as he wants him to do. All authority should be used only for increasing the efficiency of the organization. When any act on the part of the employe tends to decrease the efficiency, then the foreman should act.

An important part of the work of maintaining the efficiency at a high standard is involved in the question of promotions. It is of importance that men in the employ of the company, rather than outsiders, be promoted. Older employes are generally more loyal, and it is a great stimulant to them to know that when there is an opportunity for promotion, they will be considered, provided they have the qualifications. This knowledge makes every man willing to give the best, because he knows that he will not be forgotten when there is an opportunity to promote him.

The welfare work, which is now becoming so prominent, is more of a success when it is conducted by the men themselves than when it is directed by the company. It is perfectly proper for the company to aid, cooperate, and encourage any work of this kind, but the democratic tendencies of the times require that the actual work be left largely to committees selected by the men. If that is done, there is a possibility for cooperative effort that cannot be obtained otherwise.

Few shop managers recognize how important it is to increase the knowledge of the employes in order to improve the efficiency of the organization. A shop force that is well informed on the methods of the trade is far more efficient than one that has been trained to perform certain operations only. The wider the general distribution of knowledge of shop methods among the employes, the greater the production, and other things being equal, there is no greater aid toward increasing the efficiency of the whole organization than the reading of trade journals and mechanical books. The management should

FOSTER MACHINE COMPANY

INCREASE AND DISCHARGE SLIP

Name ..... Clock Number .....
Occupation ..... Department .....

| Increase in Rate | Discharge |
|---|---|
| Date Effective ..... | Date Effective ..... |
| Reason ..... | Reason ..... |
| ..... | ..... |
| Change in Duties ..... | Ability ..... |
| ..... | Would You Rehire? ..... |
| From ..... (Rate) To ..... (Rate) | Congenial? ..... Steady? ..... |
| ..... | Signed ..... Foreman. |
| Signed ..... Foreman. | Signed ..... Tool Man. |
| Approved ..... Superintendent. | Approved ..... Superintendent. |

Fig. 43. Record of Increases in Pay and of Men leaving the Employ of the Company

NAME AGE

NATIONALITY CITIZEN

MARRIED OR SINGLE

DATE OF EMPLOYMENT

WHERE LAST EMPLOYED

HOW LONG?

IN WHAT CAPACITY

HEALTH

HONESTY

BRAINS

GRIT

SPECIAL KNOWLEDGE

TACT

ENERGY

JUDGMENT

EDUCATION

REMARKS

IN DEPT.

Fig. 44. Special Record kept by Employment Department, giving Confidential Information relating to the Personality, Character, etc., of the Employes

do whatever it can to encourage the employes to take full advantage of the opportunities provided to obtain an education along mechanical lines from the trade literature that is easily available to anyone who cares to study.

* * *

## ELIMINATING THE V-THREAD

Several years ago, the tap manufacturers made an announcement to the effect that in the future taps with V-threads would be supplied only to order, and that all standard taps regularly carried in stock would be made with the U. S. standard thread. A similar decision has now been reached by the screw products manufacturers in the making of cap- and set-screws, the U. S. standard thread having been adopted as a single standard. As announced by the National Acme Co., Cleveland, Ohio, it is the belief among the manufacturers of cap- and set-screws that the U. S. form of thread is superior to the V-thread, and that it will meet practically all the requirements for which the V-thread has been used in the past. Among the users, also, there is a rapidly growing tendency to favor the U. S. form, and it appears to be only a question of a few years until the V-thread will have become obsolete. Complaints are also frequently made that the existence of two standards for cap- and set-screws places a handicap upon the dealer. Those offering a "complete line" are now required to stock both V- and U. S. thread screws, yet many sizes of V-thread screws are rarely, if ever, specified by users, and are, therefore, held as emergency or dead stock. Obviously, the elimination of the V-form will be welcomed by the dealers.

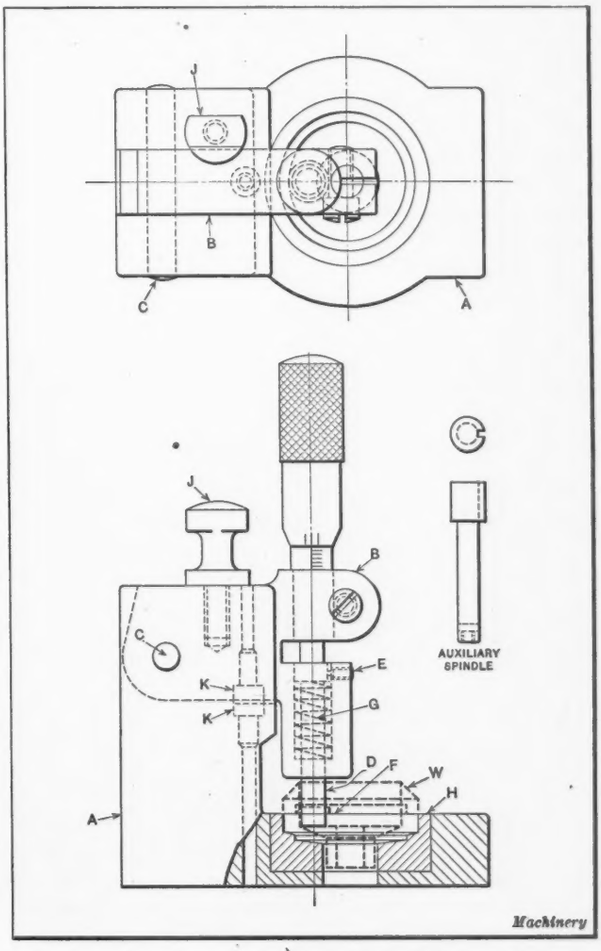
In view of the above facts, the National Acme Co. has decided to carry a complete stock of the U. S. standard cap- and set-screws only, and to eliminate the V-thread screws as rapidly as possible; V-thread screws will be made to order only when specified.

## MICROMETER GAGE

BY H. KURZWEIL

The micrometer gage shown in the accompanying illustration is used to gage the internal groove in the hook ring for a bobbin case bearing, shown at *W*. Although this gage is special in nature, gages for similar work could be made along the same general lines as that here illustrated. A standard micrometer head is held in the spindle-holder *B*, which is hinged in the milled slot of the cast-iron body *A*, by means of the pin *C*. In addition to carrying the micrometer spindle, the spindle-holder, which is made of machine steel, pack-hardened, also has a hole for carrying the auxiliary spindle *D*. This spindle is made of hardened drill rod, and has a splined head for receiving the pilot-point set-screw *E*, which acts as a key. Spindle *D* carries at its lower end the small gage pin *F*, which enters the internal groove in the work. In this way, the height of the groove is gaged as the micrometer spindle bears against the head of the auxiliary spindle.

Variation in the location of the internal groove is compensated for by pressure of the micrometer spindle against the force exerted on spindle *D* by the light expansion spring *G*. After the work is placed in the pack-hardened cold-rolled steel holder *H* in the body of the gage, the spindle-holder *B*, which has been swung back out of the way, is brought down into position as shown in the illustration. A half-turn of the slabbed-head screw *J*, secures the spindle-holder or releases it, as the case may be, which greatly expedites the working of the gage. Two hardened drill-rod pins *K* form the bearing for the gage body and the spindle-holder, when in the gaging position, and the construction provides for readily replacing or relocating these pins when worn, by means of holes, which it will be noticed, are drilled clear through the body and the spindle-holder.




Micrometer Gage for measuring Exact Height of Internal Groove in Hook Ring for Bobbin Case Bearing

# Pattern Turning

## Equipment Required and Methods Used in Turning of Different Classes of Patterns

By JOSEPH A. SHELLY

Second of Two Articles

THE first article on this subject, published in the May number of MACHINERY, described the wood turning lathe, equipment and tools for pattern turning. The present article will take up turning shoulders, fillets, small core-prints, cylindrical patterns and irregular forms; fitting flanges and bands; faceplate turning; turning small bosses; building work on the faceplate; inside turning; turning to templets; rechucking; turning eccentric rings; turning balls; and sandpapering lathe work.

### Turning Shoulders, Fillets, and Small Core-prints

In turning shoulders, the skew chisel, held on edge, is used to finish the shoulder as at *A*, Fig. 14. The groove is first roughed out, and then sized with a sizing tool, leaving enough stock for two or three cuts with the skew chisel, which should be held so that the beveled edge is in line with the shoulder. Shoulders on large pieces often have to be finished with the diamond point, as at *B*.

Fillets, as a general rule, should be turned last and finished with a round-nose tool. Small fillets can be turned accurately enough by first turning so as to leave a square cornered projection, as at *A*, Fig. 15, equal to the fillet radius. Large fillets should be turned to a templet as at *B*, roughing them out with a diamond-point tool and finishing with a round-nose tool. The gouge is rather a dangerous tool to use for this purpose, as it is likely to catch on the corners unless skillfully handled. The fillets on long slender hubs cannot be turned from the solid stock, and it is customary to turn a pin and fit a disk with the grain the opposite way, as at *C*. The fillet is formed on the disk which is glued and nailed to the hub.

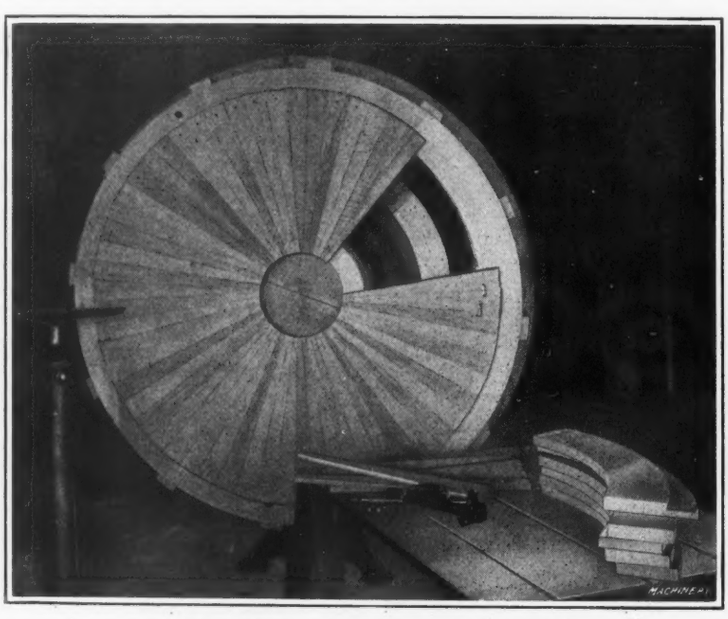


Fig. 13. Building up Work on the Lathe Faceplate

Every pattern shop should have on hand a stock of both straight and tapered core-prints, ranging from two inches down. Each print should have a pin to fit some standard size auger bit. The straight prints should be turned to the exact size at the center and perhaps 1/64 inch over size at the bottom and the top, while the tapered prints are made the exact size at the bottom. It is a good idea to leave about 1/8 inch of the tapering print straight to prevent sandpapering under size and also to help center the core, when the molder has to file the end to fit.

### Turning Cylindrical Patterns and Irregular Forms

The barrel of a cylindrical piece should be roughed off with a gouge, and a space the width of the sizing tool turned to size at each end; if the cylinder is more than 7 or 8 inches in diameter, the lathe will have to be stopped when calipering. The more spots that are sized, the easier it will be to turn the piece straight, but it often happens that the work is sized with the calipers on the ends only, and has to be turned from one end to the other with the straightedge as a guide, as shown at *D*, Fig. 15. As an aid to straight turning, a straight line is sometimes planed with the fore plane on one side of the barrel, from sizing point to sizing point. By turning to this space, which may be chalked with blue to make it prominent, much handling of the straightedge can be avoided. The final testing, however, should always be done with a

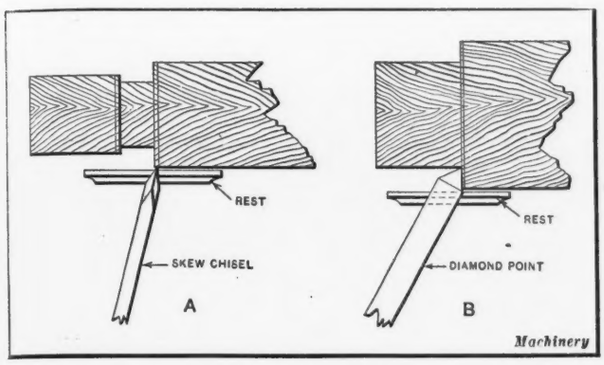



Fig. 14. Turning Shoulders

straightedge. This method is also applicable to sizing and turning tapered or conical work.

Irregular shaped pieces are given the desired form by turning them to fit templets, as shown at *A*, Fig. 16, or, if they are parted pieces, they may first be centered in the lathe and then taken apart and an accurate outline of the desired shape laid out on the joint. By cutting to these lines on one edge on the band saw an excellent guide for turning to shape is obtained when the pieces are put together again and placed in the lathe. An example is shown at *B*.

Thin stock should be used in making templets, and the edges should be beveled so as not to be over 1/8 inch thick; these templets are chalked and rubbed on the work to see where it is necessary to remove the stock. In using a templet on work such as illustrated at *A*, a section at each end should first be turned true for the templet to ride on.

Long slender pieces, like piston-rods, are difficult to turn, because they spring away from the tool and chatter and vibrate so that it is impossible to turn them round or smooth. A temporary wooden steadyrest will help to overcome this; the work may be revolved slowly at first, and a true spot about two inches long turned in the center to set the steadyrest jaws against. Care must be taken not to spring the piece in setting the steadyrest and the turning must be done carefully or else the true spot will wear away too quickly. When the rest is removed, the spot turned first may be planed flush with the rest of the rod. Straight rods are sometimes made by turning each end to size and planing from one end to the other, finishing them by sandpapering in the lathe.

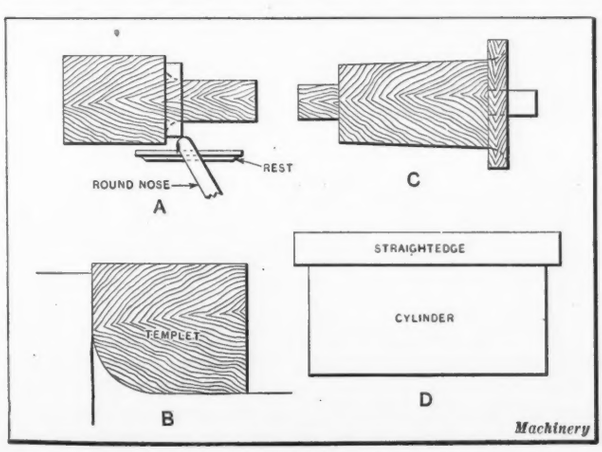



Fig. 15. (A, B, and C) Methods of forming Fillets. (D) Testing Cylinder with Straightedge

### Fitting Flanges and Bands

A standard joint for flanges is shown at *C* in Fig. 16. A recess is turned in the print to receive the flange. As a rule, the flange is fastened from the inside with screws, which necessitates taking the pattern apart. This is objectionable, as is also the fact that the flange cannot well be moved after it is in place. Fitting over the print and against the shoulder formed by the barrel, as at *D*, is perhaps the most satisfactory way, as the flange may be nailed or screwed from the end, and if it is to be built of segments on the barrel, it will be found the handiest method, besides lending itself well to alterations. The shoulders against which the flange fits should be turned under or hollow so that the flange will make a tight joint. If the flanges are solid or built together of segments they should not be sawn to size until they are ready to be used. They will fit much better if this rule is observed. Long straight pieces will sometimes have raised bands, as at *E*, that will require a lot of time and the removal of considerable stock if turned from the solid. To overcome this, grooves are turned, and the bands built in of segments.

### Turning for Squares and Hexagons—Faceplate Turning

Portions of turned patterns are often made square or hexagonal to take a wrench, and it is customary to turn these parts round and divide the circumference with a pair of dividers in laying off the lines to cut to. After the circle is divided the piece is laid on a straight surface and a parallel straightedge, wide enough to be in line with the center, is placed beside it, as at *A*, Fig. 17, for drawing the lines. Two parallel straightedges may also be fastened together at right angles and used for the same purpose, as at *B*. To determine the size of the round for a given square or hexagon, it may be laid out full size or calculated. If square, the distance *d* across the flats multiplied by 1.4142 will give the distance *D* across the corner (see Fig. 18); if hexagonal, the distance *d* across the flats multiplied by 1.1547 equals the distance *D* across the corners.

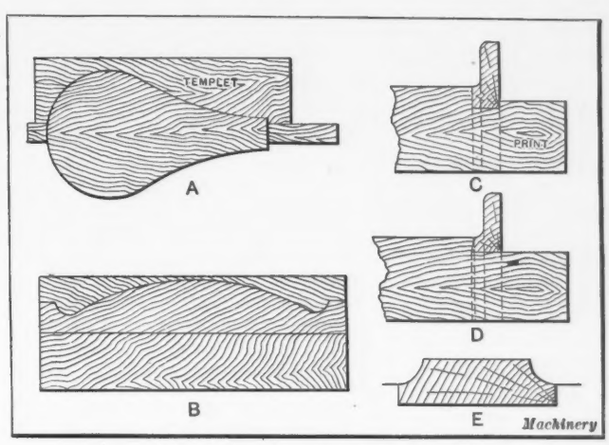



Fig. 16. (A and B) How Irregular Forms can be turned. (C, D, and E) Fitting Flanges and Bands

Faceplate or chuck plate turning differs from that previously described in that the work is supported at one end only, and, for the most part, the wood grain presented to the tools will run in a different direction. This branch of turning consists of facing and outside and inside turning or boring.

### Turning Small Bosses

The quickest way to turn a small boss is to fasten a piece to the screw chuck, turn it to the diameter at the base of the fillet, and face off the end. The dividers are set to the radius of the boss, and, with the point of one leg in the

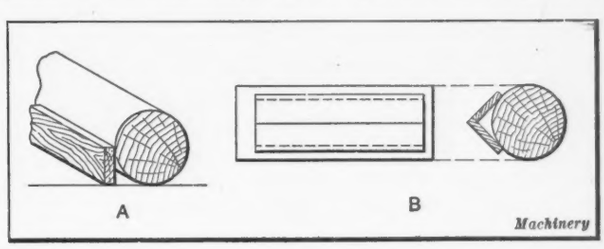



Fig. 17. Laying out Square or Hexagonal Patterns

center, a circle is drawn with the lathe running. The rest is then swung around parallel to the axis of the work, and the thickness laid off with a second pair of dividers; if there are a number of bosses to make, it will save time to have two pairs of dividers. With a cutting-off tool a groove is turned about 1/8 inch deep at the thickness line. The fillet is turned with a round-nose tool and sandpapered and varnished before the boss is cut off. If a central hole for a skewer is needed, it can be bored with an auger bit, the lathe being run slowly, but the hole must not be deep enough to strike the central screw. In cutting off, the tool is held in the same manner as a sizing tool and the right hand is used to catch the boss, as shown at *A*, Fig. 19.

Another way to turn larger bosses and facing pieces is to use a suitable wooden faceplate. It should be trued up and a circle scribed corresponding to the rough outside diameter of the boss. The piece to be turned is fastened to the faceplate with three or four brads, driven with the heads protruding about 1/8 inch so that they may be withdrawn. The outside is turned with a diamond-point tool, and the fillet finished to the scribed line with a round-nose tool. The fillet should be sandpapered in the lathe, but the face should not, as the nails are in the way. The stock should be planed to the exact thickness before turning. Bosses, core-prints, etc., requiring a central pin may be quickly made by planing up the stock and laying out the circles for sawing. In the center of each circle a hole is bored part way through, and a dowel-pin glued in and allowed to extend the required length of the pin. A hole is turned in the faceplate to fit the pin and the pieces are fastened with nails.

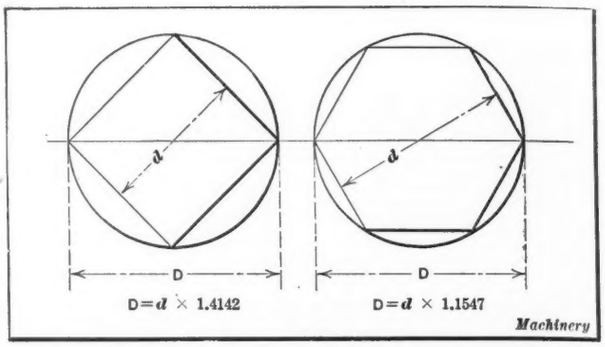



Fig. 18. Relation between Diameter and Width across Flats for Square and Hexagonal Forms

### Facing

Turning a surface that is at right angles to the axis of revolution is called "facing," and when a piece is so turned it is said to be "faced off." In facing, the rest should be set a trifle below the center, and if the surface is small, say 2 feet or so in diameter, the roughing off may safely be done with a gouge. The tool should be sharp and the surface should be tested with the lathe running, by holding a straightedge against the face and noting where the stock should be removed. When the face is as straight across as it can be made with the gouge, it should be finished with the scraping chisel. The lathe should be stopped for testing and the straightedge chalked. If it is straight there will be a chalk line across from side to side when the edge is rubbed (see sketch *B*, Fig. 19). If the piece to be turned entirely covers the faceplate, it is well to make the latter a trifle hollow, as at *C*, and if a built-up ring is to be turned, a space large enough for the ring is all that will be required. The outer part of chuck plate *D* has been faced for a built-up ring. A center should always be made on every faceplate with the trammel or divider points; in fact, a center should be made on all turned pieces whether the immediate need for it can be seen or not.

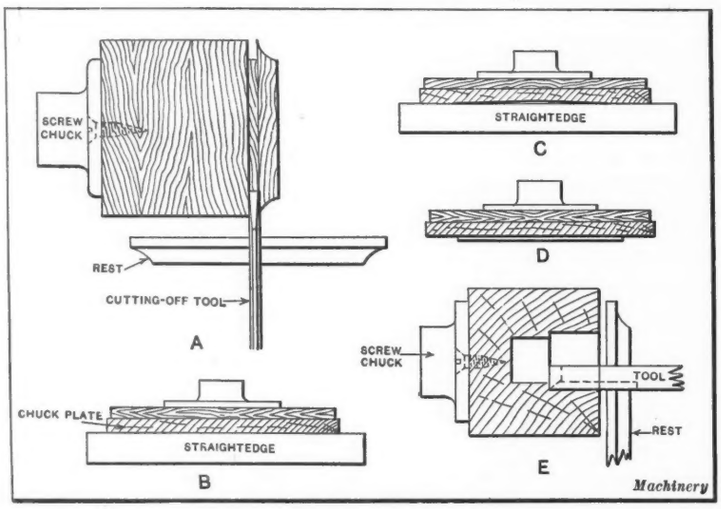



Fig. 19. Examples of Faceplate Turning

When turning large faceplates, the diamond-point will be found a safer tool to rough off with, particularly if the plate is considerably out of truth. The finishing should be done with a scraping chisel, and the surface should be tested with a straightedge. Segment courses should be faced with the same tools, following the same general rules, but for finish courses that are to be built on, the toothed scraper will be found handy. When facing segments, in addition to testing them from side to side with a straightedge, a segment in each course should be tested across the face with a square blade, and it is a good plan to make them slightly hollow so that the next course will be sure to show tight joints at the edges. On very large jobs there is likely to be more or less vibration of the faceplate which will cause a scraping tool to dig in and catch; this can be obviated by finishing the face and outside of such rings with the toothed scraper and removing the tooth marks with a sharp block plane set to make a very fine cut. The plane is held on the face or outside of the ring while it is slowly revolved.

Too much care cannot be exercised in fastening work to the faceplate. The screw should fit the holes bored for them as three screws in tightly fitting holes will hold more than seven or eight in holes that are too big. Work that has been glued to the faceplate does not require as many screws as work applied dry.

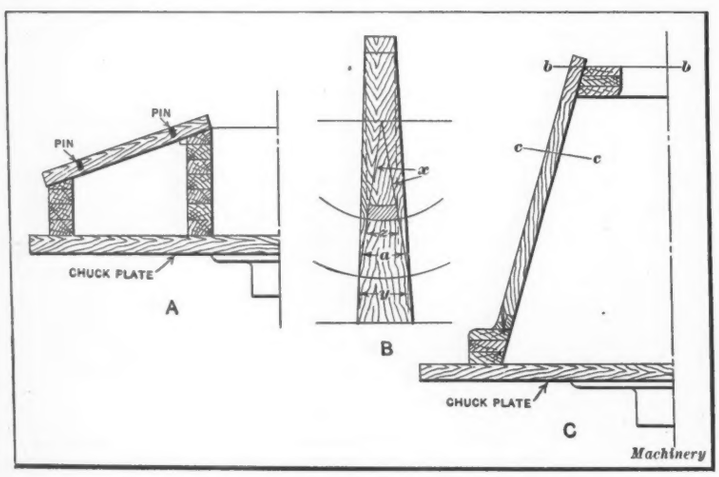



Fig. 20. Methods of constructing Cone-shaped Patterns

### Building Work on the Faceplate

Large work is always built on the faceplate without removing the latter from the spindle.

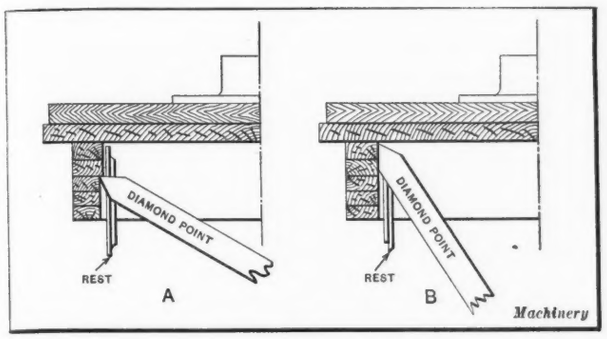



Fig. 21. Inside Turning

Fig. 13 shows a method of building webs or plates by means of sectors, with the grain running from the center to the outside. The pieces are nailed, screwed, and glued to the outer and inner segment rings, pinch-dogs being used to draw the joints together. A portable bench is handy for work of this kind. In the particular job shown under construction in the illustration, the ends of the segments and the joints between the sectors were finished on the disk grinder.

This method of building is often used for truncated cone-shaped patterns as at *A*, Fig. 20, which shows a pattern for the cast-iron bottom of a steel air vessel in course of construction. The outside and inside rings are built of segments and turned at an angle for the staves with the grain running to the center. These staves were planed with a round-soled plane to fit, and were nailed and glued to the segment rings. The pattern was finished outside and rechucked for finishing the inside. To get the thickness of the bottom when turning the inside, two 1/4-inch holes were bored when the outside was finished, and pins equal in length to the required thickness were driven in flush; the inside was then turned in a straight line from one pin end to the other.

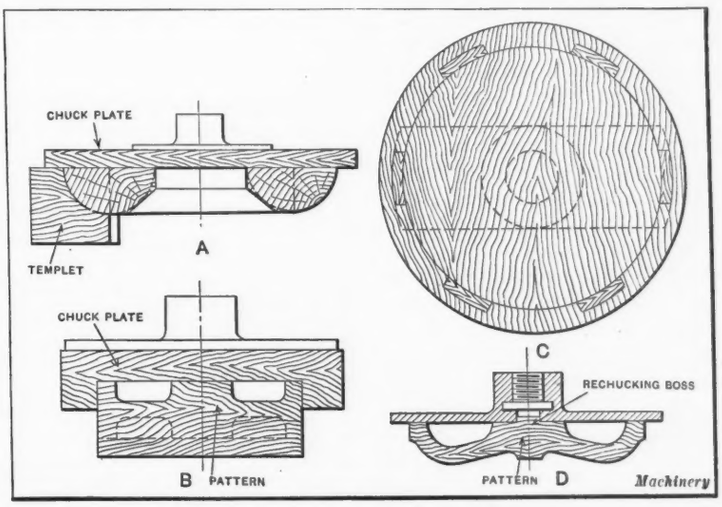



Fig. 22. Additional Examples of Faceplate Work

Another cone-shaped pattern for the under support of a boring mill bearing is partly shown at *C*, Fig. 20. The top ring in this case is turned and centered on a support built on the chuck face on which the large ring is built and turned. This support is not shown in the illustration, but may be made of box form with a top to fasten the smaller flange to; it should be stiff and securely fastened to the chuck face by screws. The staves are laid out, as at *B*, by drawing two concentric circles, representing the large and small diameters at the extreme ends of the staves. The larger circle is divided into an equal number of parts and lines $x$ are drawn from the spacing points to the center, giving the widths $y$ and $z$ at the widest and narrowest part of the stave and also the included angle $a$ of the edges in a plane b–b. This angle or taper is next transferred to one edge of a stave, and this edge is planed by hand to the lay-out lines. This edge may then be used to set the bevel while the stock is held against the face with the blade at right angles or in plane c–c. The bevel is next used for setting the fence on the jointer. A shoulder was turned on the bottom ring against which the wide ends of the staves were fastened with glue and secured by toe nailing into the ring. Screws were used for fastening at the top. The staves were made tapering with square edges, then beveled and worked out on the inside with a round sole plane, a templet being used at each end to make the curvature right, and a straightedge to test with in finishing the intervening space straight; the staves had to be worked carefully, as this pattern was not turned inside. The rebate to fit against the shoulder was cut with a backsaw, chisel, and flat gouge.

### Tools for Facing Large and Small Disks—Inside Turning

Small disks should be roughed off with the gouge, but the diamond-point tool will be found more suitable for the larger ones, as it offers less resistance to the high spots, when they come around, and there is little danger of its being caught. The gouge should be used, however, on large and small work to reduce it to size, and should be very sharp to produce smooth surfaces. The edge should be tested by squaring from the face and the piece should be brought to within 1/16 inch of size before finishing with the scraping chisel. The same tools may be used for finishing segment jobs, but the gouge must be used carefully, if at all, on the larger jobs. The toothed scraper may be used for finishing outside segment work before the scraping chisel is applied.

For inside pattern turning, it is safer to eliminate the gouges and substitute the diamond-point and round-nose tools. A very good tool for putting a rough hole through a disk is shown at *H* in Fig. 7 in the May installment. It is known as a cutting-off tool; with it a piece 3 inches in diameter and about 11/4 inch thick may be taken out at one cut. The diamond-point, when used on inside work, should be ground at such an angle that the leading edge will not strike the faceplate before the point. Segment work should preferably be roughed off with the point of the tool as at *A*, Fig. 21, and finished with the scraping edge, as at *B*. Very small holes are always hard to turn, as the diamond-point often cannot be used, but they can be finished satisfactorily with a narrow square-nose tool that is ground to cut on the side, as at *E*, Fig. 19. The end of this tool may be used for boring the rough hole and the side for finishing. It saves time to start small holes by boring a smaller hole first with an auger bit.

### Turning to Templets—Rechucking

The templets used for shaping pieces on the faceplate need be only half sections of the form desired, as shown in Fig. 23. In turning elbows and U-pipes *C*, it is better to turn the inside and outside diameters and the thickness, and then

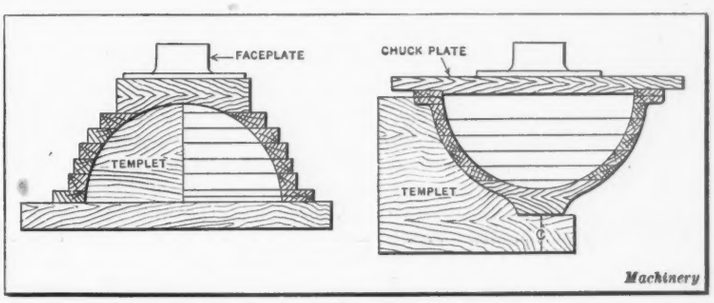



Fig. 23. Turning to Templets

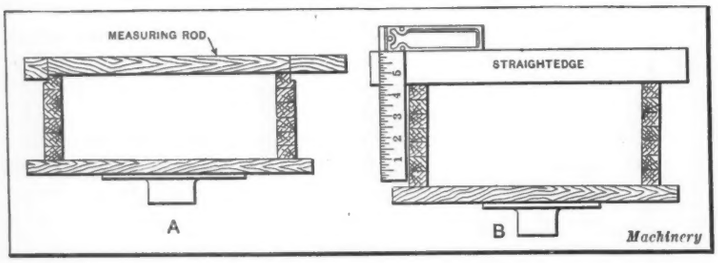



Fig. 24. Sizing and testing Faceplate Work

turn from the center to the outside and to the inside, using a quarter-round templet, as at *A*, Fig. 22. The work may be checked with a half-round templet when finished. In turning quarter-rounds, it is a good plan to bevel the corners away.

When a piece that is to be shaped on both sides has one side finished, it must be reversed and again placed in a central position on the faceplate to finish the opposite side. With a small piece, this is done by turning a recess in the faceplate to fit the outside diameter tightly, as at *B*, Fig. 22. If the piece is small no screws will be needed, the friction being enough to hold it in place, but if it is fairly large, it would be safer to use a couple of screws. With large pieces, there are objections to turning grooves in the faceplate, so it is the practice to saw segments 3/16 to 5/16 inch thick and attach them to the faceplate as at *C*, leaving sufficient stock for turning to size; these segments may be spaced some distance apart, and they can be arranged for chucking both inside and out. The diamond-point tool should be used for this work. Bosses are sometimes turned on pieces to fit the hole in the faceplate, as at *D*, for the purpose of rechucking.

### Sizing and Testing Faceplate Work—Keeping Segment Work Square

The outside calipers may be used for sizing small pieces with the lathe in motion, as previously explained, but for

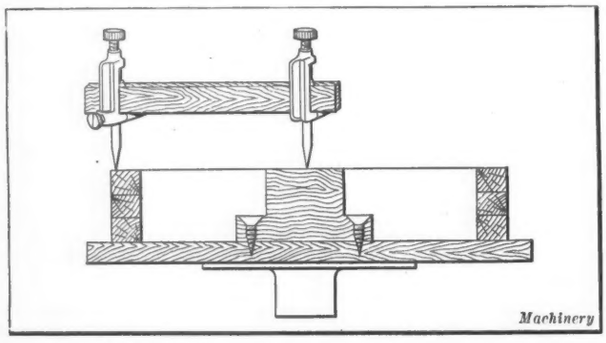



Fig. 25. Use of Trammels in Connection with Segment Work

the larger pieces, the lathe will have to be stopped. The inside calipers should never be applied to work while the lathe is running. The draft in holes may be tested by measuring the hole top and bottom with the inside calipers and testing for straightness with a straightedge. For sizing ring work over 2 feet in diameter, a good plan is to use a measuring rod, as at *A*, Fig. 24. This gives the inside and outside diameters and is used as shown. One end of the rod has a piece bradded to it to notch over the edge. To test the draft, a straightedge and square are used as at *B*. The square with a sliding blade is well adapted to this work.

In facing segment work, blocks should be bradded in the center to raise the center about flush with the segment faces, and the segment edges on every second course turned true for 1/8 inch. This is to prevent running out of square with the face. A center may be made on the raised center blocks and a circle scribed on the face as a new setting line for the next course. Trammels used in this way are shown in Fig. 25.

### Turning Flywheel and Pulley Rims

In turning flywheel rims, the center course or courses should be turned to a thickness equal to the thin end of the spider arm plus a small amount left for facing when the ring is rechucked. The object in doing this is to be able to cut on the glue joint when making the gains or sockets for the arms. This center course, or courses, is marked No. 1 in the view *A*, Fig. 26. The fillet that connects the inside of the rim and the arm is turned from course No. 2 and course No. 3 extends to the top. Course No. 3 is faced off until the distance from the face to the center of course No. 1 is equal to half the face of the wheel. The center is blocked up level with the face and the inside diameter laid off with a pair of trammels. The tapered part and the inside of the bead course are then turned and a center line scribed. The bead and fillet are then turned and fitted to a templet, as at *B*. The rim is next rechucked, as at *C*, the bead finished, and the inside and bead sandpapered. The spider arms are then gained and fastened to the rim; next course No. 1, which is now uppermost, is faced off flush with the

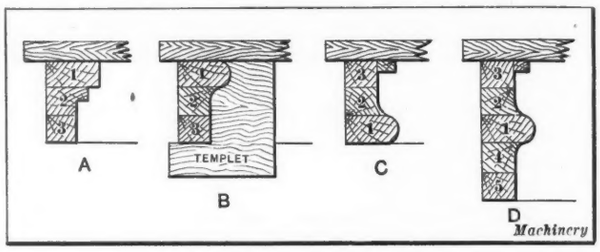



Fig. 26. Turning Flywheel and Pulley Rims

arms, and courses Nos. 4 and 5 are applied and finished as at *D*. The outside of the rings should be turned off roughly before finishing the inside, so that the work will run in better balance, but the outside should not be turned to size until fully built up and finished inside, unless there is some good reason for it. It is sometimes possible to turn rims on the inside without rechucking, when the face is wide and the straight part on the inside runs far enough away from the chuck plate to turn the fillet at the base of the bead. Partings for turned work are of the pin and socket variety. A variation from this is the loose rim turned to fit a recess that is used for pulleys to avoid parting the web.

### Turning Holes and Recesses off Center—Turning Eccentric Rings

Holes and recesses that are off center may be turned and bored by laying out the position of the holes, as at *A*, Fig. 27, and boring a 1/4-inch hole through each center and a corresponding hole in the chuck-plate center. A 1/4-inch dowel-pin is pushed through the pattern into the hole in the plate to center it, as at *B*. The pin is withdrawn after the pattern is fastened, which may be done with screws or with nails if the pattern is light in weight. In turning pieces off center, the lathe should be run slowly and the chuck plate counterbalanced if necessary. This is an excellent way of turning countersunk screw holes that are to be cast.

The drawing for an eccentric ring usually has the inside and outside diameters and the thicknesses at opposite sides

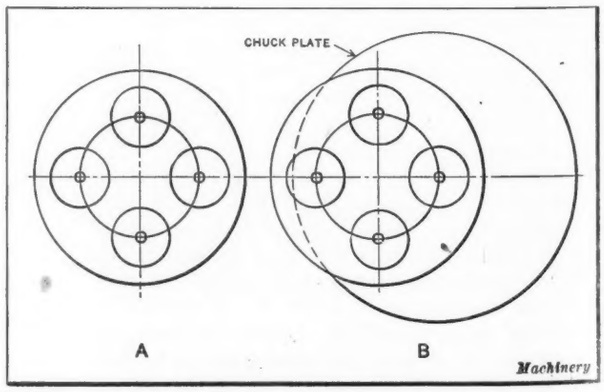



Fig. 27. Turning Holes or Recesses off Center

given, as at *A*, Fig. 29. It is a good plan to build these rings as though they were to be concentric, leaving plenty of stock on the outside. The inside of the ring is turned first. A cross-piece for a center line is fitted into place and the outside of the ring laid out with about 1/16 inch left for turning, as shown at *B*. The ring is then taken from the faceplate and the square center lines are drawn on the inside before the ring is bandsawed on the outside lines. A center line is next laid out on the faceplate, and on this another center is located a distance from the true center, equal to one-half the difference between the thick and thin sides of the ring. From this center a circle is scribed corresponding to the inside diameter of the ring at the bottom, and the ring is rechucked for turning the outside by setting the inside to the center line and the circle.

### Turning Balls

To turn a parted ball pattern, two pieces of suitable size are turned to fit together with a pin and socket joint as indicated at *A*, Fig. 28. The thickness of these pieces should be a little greater than the radius of the finished ball with the outside diameter about 1/16 inch over size. Rechucking is done by means of the pin or socket; the outside is turned to the exact size and to the required thickness and the corners turned away as at *B*. A templet of thin wood or sheet metal is next used to finish the half ball, as at *C*.

If the ball is to be a solid one, it is turned carefully to templet and about 1/16 inch over size, as at *D*. The ends are then cut off and the ball fitted to a cup chuck to within 3/16 or 1/4 inch of the center, as at *E*. This chuck is turned away on the inside so that the ball when pushed tightly into it will be held by a ridge about 3/8 inch wide at the face. A groove is turned with a 1/8-inch chisel at the center of the ball and to the exact diameter; the ball is then revolved in the chuck so that another groove may be turned to the same diameter and at right angles to the first one. To finish the ball, it is only necessary to turn away the stock between the grooves, which must be done carefully to prevent the ball from flying from the chuck.

### Sandpapering Lathe Work

Straight turned pieces should be sandpapered with the paper wrapped around a straight block; if the inside of a large ring is to be sanded, the block may be rounded to fit the inside of the ring. Sandpaper wrapped around a straight dowel-pin will be found an effective means for sanding very small holes. Fillets and round outlines are sanded with the sandpaper held in the hands. It should never be held in one spot, but moved back and forth so that the abrasive will not cut a series of parallel grooves. Coarse sandpaper should be used first and the finishing should be done with a finer grade. Lathe work should always be given a coat of shellac, which is allowed to dry and is sandpapered before being taken from the lathe, unless pieces are to be fitted and glued to it, in which case the shellac would prevent the glue from sticking.

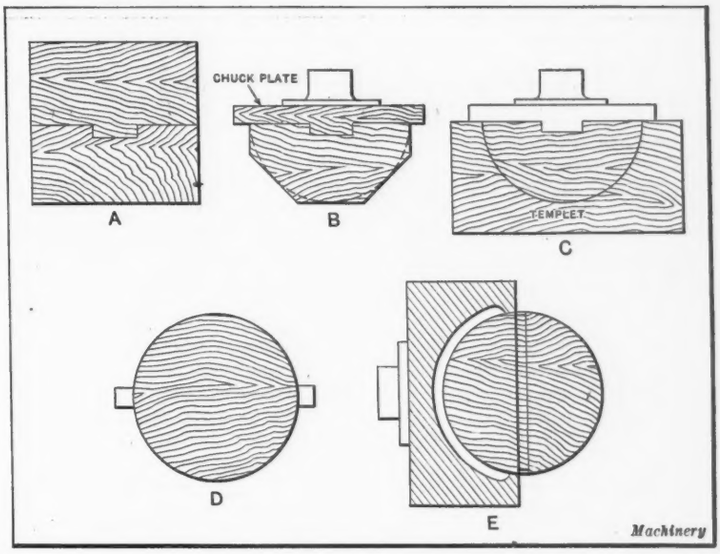



Fig. 28. Turning Balls or Spherical-shaped Parts

* * *

## METHOD OF CHECKING PRODUCTION

At the plant of the New Process Gear Corporation, in Syracuse, N. Y., a graphical method has recently been adopted for use in maintaining a constant check upon the rate of production that is attained. The chart used for this purpose extends across one wall of the inspection department, and is made from a piece of coordinate paper approximately three feet in width. Four record lines are drawn on this chart, and these represent the number of parts produced each day which are found to be in the following conditions: First, "defective work," caused by imperfections of the material, which were not discovered until machining operations had been started; second, "spoiled work," resulting from mistakes made by employes or from an unsatisfactory quality of workmanship; third, "regular production," which includes only those parts that are passed by the inspection department; fourth, "repair work," which includes all parts that are rejected by the inspection department, but that can be corrected in the "hospital" or repair shop. As production reports come in, they are entered upon this chart, and it will be apparent that the total number of pieces which were reported is represented by the sum of the numbers corresponding to the position of the four curves on this chart. The advantage of this method is that it enables the production manager, or any other official, to see at a glance just how conditions stand in the plant, and if there is an abnormally high amount of defective, spoiled, or repair work, the necessary steps may be taken to find the cause of the trouble and prevent its recurrence. E. K. H.

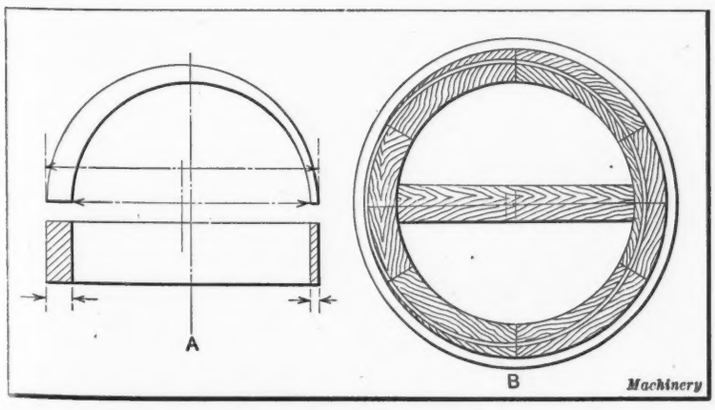



Fig. 29. Turning Eccentric Rings

* * *

The *Scientific American* quotes a contemporary as saying that a file, when new, if viewed under a strong magnifying glass, will be found to consist of fine points or teeth so far as the cutting surface is concerned, and if passed over a piece of hard steel or other hard resistant metal it will be found that the majority of these teeth splinter off, leaving a very dull set of cutting points. For this reason, it is best always to use files first on brass and copper alloys (as this saves the teeth from breaking away, while the heat engendered by the working friction anneals them somewhat) and later on wrought iron and mild steel, harder steel and cast iron taking the last place. Afterward the files will need to be restored, if they are to be of further use.

# Materials of Machine Construction

BY G. H. KENDALL

**Mechanical engineers, designers, and draftsmen frequently have occasion to compare the cost and physical characteristics of different metals before specifying any one material on a drawing for a certain purpose. The following review of the materials most commonly used in machine design give, in a comprehensive manner, the most important information relating to each. This information is based upon a bulletin prepared for a large and well-known machine-building concern for the use of its engineering staff.**

As no text-book at the present time covers all the materials commonly used in machine construction in such a brief and comprehensive manner that reference can easily be made by a designer or draftsman to the particular material that he may want to use, a large industrial concern has had the required information collected and arranged in bulletin form, from which the following paragraphs have been prepared. The bulletin is intended to give the designer and draftsman a brief outline only of the principal uses, comparative costs, and chief characteristics of the various metals and to enable him to make a fair comparison of these materials. It is not intended to cover comprehensively all the peculiarities and characteristics of the different metals as, if that had been done, the purpose of the compilation would have been defeated, the intention being to present briefly and clearly the most important points only.

While the cost per pound has been given of the various materials, it should be understood that the factor of cost, which is always quite flexible, is at present so uncertain that the prices quoted herein should be accepted subject to variation.

### Cast Iron

Cast iron is almost universally used for forms that must be shaped by casting, especially where weight is not objectionable, or where considerable weight is desired. It should not, however, be used for parts which are subject to shock or strain, as it is weak in tension and brittle. Cast iron makes a good bearing surface and is cheap. Surfaces of cast iron parts which are subject to continuous wear will last much longer if they are chilled.

*Properties*—Cost, 4 cents per pound. Weight, 0.260 pound per cubic inch; 464 pounds per cubic foot. Specific gravity, 7.21. Strength: tension, 16,500 pounds per square inch; compression, 95,000 pounds per square inch; shear, 20,000 pounds per square inch. Melting point, 2300 degrees F.

### Malleable Iron

Malleable iron is made by annealing white cast iron. It is much stronger than cast iron, but weaker than steel castings, and can be bent and worked to some extent. Malleable iron cannot be welded, but can be hardened, and when so treated is especially adapted to the hardware class of castings. It is suitable for parts which are subjected to shock or strain, such as small levers, links, rod connections, etc. As a rule, it is better to make heavy castings of steel. Malleable iron makes a good substitute for steel castings on account of its low cost.

*Properties*—Cost, 10 cents per pound. Weight, 0.260 pound per cubic inch; 464 pounds per cubic foot. Specific gravity, 7.21. Strength: tension, 35,000 pounds per square inch; compression, 42,000 pounds per square inch; shear, 20,000 pounds per square inch. Melting point, 2700 degrees F.

### Wrought Iron

Wrought iron is the purest form of commercial iron and has a fibrous structure. It is more easily forged than steel and can be readily welded; it cannot be hardened or heat-treated the same as steel, but can be casehardened by the use of cyanide of potassium. It has a high electrical conductivity and magnetizes easily. Wrought iron should never be used for bearing surfaces, as its slag content causes heating and wear, but it is suitable for chain links, rods, angles, braces, levers, etc., and for use when subjected to high temperatures. Some of the best grades of wrought iron are known as "Norway iron," but are actually grades of iron made in Sweden.

*Properties*—Cost, 5 cents per pound. Weight, 0.278 pound per cubic inch; 480 pounds per cubic foot. Specific gravity, 7.75. Strength: tension, 48,000 pounds per square inch; compression, 46,000 pounds per square inch; shear, 40,000 pounds per square inch. Melting point, 2920 degrees F.

### Dur-iron

Dur-iron is a cast iron containing about 12 per cent of silicon. Castings made from this material are used only for parts requiring high acid or corrosion resistance.

*Properties*—Cost, 28 cents per pound. Weight, 0.260 pound per cubic inch; 460 pounds per cubic foot. Specific gravity, 7. Strength: tension, 13,000 pounds per square inch. Melting point, 2190 degrees F.

### Semi-steel Castings

Semi-steel castings are a better grade of cast iron, being made by adding about 25 per cent of steel scrap to the required cupola charge for cast iron. These castings have high wearing qualities, are close-grained, easy to machine, and are considered better than malleable iron for the same class of work.

*Properties*—Cost, 15 cents per pound. Weight, 0.270 pound per cubic inch; 470 pounds per cubic foot. Specific gravity, 7.7. Strength: tension, 30,000 pounds per square inch; compression, 40,000 pounds per square inch; shear, 30,000 pounds per square inch. Melting point, 2650 degrees F.

### Steel Castings

Steel castings are commonly used for forms that must be shaped by casting and which are to be subjected to shock and strain, or where a large casting is required, which must be of frail construction. Steel castings are much stronger than cast or malleable iron castings of the same weight, and are particularly adapted for such parts as pinions, long levers, brackets, clutch shifter parts, bevel gears, housings, connecting-rods, etc. Care must be used in designing steel casting parts to avoid great differences in sectional area of adjoining portions, and allowance must be made for shrinkage distortions.

*Properties*—Cost, 25 cents per pound. Weight, 0.280 pound per cubic inch; 481 pounds per cubic foot. Specific gravity, 7.87. Strength: tension, 65,000 pounds per square inch; compression, 70,000 pounds per square inch; shear, 50,000 pounds per square inch. Melting point, 2450 degrees F.

### Stubs Steel

Stubs steel is used for small pins, studs, shafts, screws, etc., requiring strength and toughness. It can be easily machined and hardened, and has a bright finish. It comes in sizes up to ⅝ inch in diameter, and should be used where the largest diameter does not require further machining.

*Properties*—Cost, 27½ cents per pound. Weight, 0.283 pound per cubic inch; 489 pounds per cubic foot. Specific gravity, 7.85. Strength: tension, 70,000 pounds per square inch. Melting point, 2600 degrees F.

### Cold-rolled Steel

Cold-rolled steel is a low-carbon steel. The stock comes in rods having a bright finish and does not vary over 0.001 inch in diameter. It is universally used for shafting and machine parts which are not subject to severe strain and where the largest diameter is not to be machined. If it is planned to machine the largest diameter of the piece or to harden it, machine steel should be used. Cold-rolled steel will caseharden and forge readily.

*Properties*—Cost, 5 cents per pound. Weight, 0.283 pound per cubic inch; 489 pounds per cubic foot. Specific gravity, 7.83. Strength: tension, 65,000 pounds per square inch; shear, 50,000 pounds per square inch. Melting point, 2600 degrees F.

### Machine Steel

Machine steel is a black stock of a better grade of steel than cold-rolled steel and requires machining. It contains from 0.25 to 0.45 per cent carbon. It is the most commonly used steel, and is adapted for all machine parts that are not subject to strain or shock. For short shafts, studs, arbors, etc., it will give long service and withstand considerable strain if casehardened. It can be readily hardened, forged, and welded.

*Properties*—Cost, 4 cents per pound. Weight, 0.283 pound per cubic inch; 487 pounds per cubic foot. Specific gravity, 7.80. Strength: tension, 80,000 pounds per square inch; shear, 57,000 pounds per square inch. Melting point, 2600 degrees F.

### Lead-screw Steel

Lead-screw steel is a better grade than machine steel, and contains from 0.60 to 0.70 per cent carbon. Where machine parts are subjected to strain and shock such as shafts, studs, arbors, etc., which require a tough steel without hardening, lead-screw steel is commonly used.

*Properties*—Cost, 7 cents per pound. Weight, 0.283 pound per cubic inch; 485 pounds per cubic foot. Specific gravity, 7.75. Strength: tension, 90,000 pounds per square inch; shear, 60,000 pounds per square inch. Melting point, 2600 degrees F.

### Tool Steel

Tool steel is a commonly used high-carbon steel containing 0.80 to 1.00 per cent carbon, and is suitable for all machinery where the parts are subject to hard, continual use and strain. When hardened, it is a very long wearing material for parts such as gage shoes, arbors, straightedges, locating pins, thrust washers, etc. It can be easily hardened and annealed, but it is practically impossible to weld it.

*Properties*—Cost, 18 cents per pound. Weight, 0.282 pound per cubic inch; 481 pounds per cubic foot. Specific gravity, 7.72. Strength: tension, 103,000 pounds per square inch; shear, 80,000 pounds per square inch. Melting point, 2600 degrees F.

### Spring Steel

Spring steel is a high-carbon steel containing from 0.90 to 1.10 per cent carbon and acquires by hardening and tempering the elastic qualities required in making springs.

*Properties*—Cost, 24 cents per pound. Weight, 0.282 pound per cubic inch; 480 pounds per cubic foot. Specific gravity, 7.70. Strength: tension, 120,000 pounds per square inch; shear, 83,000 pounds per square inch. Melting point, 2600 degrees F.

### Manganese Steel

Manganese steel is an alloy steel containing manganese. It is practically non-magnetic. Castings which are made of this grade of steel cannot be machined except by grinding and their use is restricted to parts which are to be subjected to the most severe shock and wearing action, such as crushing jaws and rolls, car wheels, brake-shoes, steam shovel teeth, special gears, etc. Manganese steel is chiefly noted for its wear-resisting qualities.

*Properties*—Cost, 32½ cents per pound. Weight, 0.284 pound per cubic inch; 490 pounds per cubic foot. Specific gravity, 7.88. Strength: tension, 90,000 pounds per square inch; compression, 163,000 pounds per square inch; shear, 80,000 pounds per square inch. Melting point, 2450 degrees F.

### Nickel Steel

Nickel steel is an alloy steel containing from 3 to 5 per cent of nickel for machine uses. When properly heat-treated, it is much stronger than tool steel, but should not be used without heat-treating. It is suitable for parts requiring great strength, ductility, elasticity, abrasion and corrosion resistance—for example, axles, spindles, light-weight frames (such as for bicycles), rivets, propeller shafts, gun barrels, armor plate, etc. It is easily cast and forged, but cannot be welded. When alloyed with chromium or vanadium, it is largely used for crankshafts, special spindles, automobile axle parts, etc. The strongest nickel steels are made from low-carbon steels.

*Properties*—Weight, 0.283 pound per cubic inch; 484 pounds per cubic foot. Specific gravity, 7.73. Strength: tension, 100,000 pounds per square inch; shear, 95,000 pounds per square inch. Melting point, 2500 degrees F.

### Chromium Steel

Chromium steel is a low-carbon alloy steel, containing less than 3 per cent of chromium, which should not be used without heat-treating. It is very strong, hard, and elastic, and is adapted for use in safes, plows, etc. It is generally alloyed with nickel or vanadium and is then used largely for crankshafts, special spindles, gears, etc.

*Properties*—Weight, 0.283 pound per cubic inch; 484 pounds per cubic foot. Specific gravity, 7.73. Strength, according to composition and heat-treatment. Melting point, 2600 degrees F.

### Vanadium Steel

This is another alloy steel containing small amounts of manganese and vanadium, which should not be used without heat-treating. It is similar to nickel steel, but possesses special qualities for resisting continued severe shock and vibrating stresses. For this reason it is often referred to as "anti-fatigue" steel. Vanadium steel can be welded. Its uses are the same as those of nickel steel. Chromium-vanadium steel, in the annealed state, has a tensile strength of 134,000 pounds per square inch, and when heat-treated, has a tensile strength of up to 210,000 pounds per square inch.

*Properties*—Weight, 0.282 pound per cubic inch; 484 pounds per cubic foot. Specific gravity, 7.72. Strength, heat-treated: tension, 140,000 pounds per square inch. Melting point, 2600 degrees F.

### Tungsten Steel

Tungsten steel is an alloy containing from 8 to 18 per cent of tungsten and various other elements. It is also known as mushet steel and high-speed steel. Its chief use is confined to making cutting tools, and it is valuable in that it retains its hardness even at a red heat. Tungsten steel should be annealed for machining, and hardened according to the directions for each brand given by the makers of the steel.

*Properties*—Weight, 0.282 pound per cubic inch; 481 pounds per cubic foot. Specific gravity, 7.7. Strength: tension, 130,000 pounds per square inch. Melting point, 2600 degrees F.

### Brass

Brass is an alloy of copper and zinc. The strongest and hardest brass, although more brittle, is produced by using from 40 to 45 per cent of zinc for castings and from 20 to 30

per cent of zinc for rods, wire, etc. It is used chiefly for bearings and bushings, oil-cups and lubricating systems, tank linings, small machine castings which require corrosion-resisting qualities, etc. Brass is a poor conductor of electricity. It can be readily cast and rolled. Bronze alloys should be used when a more durable bearing is desired.

*Properties*—Cost, 20 cents per pound. Weight, 0.303 pound per cubic inch; 523 pounds per cubic foot. Specific gravity, 8.41. Strength: tension, 20,000 pounds per square inch; compression, 12,000 pounds per square inch; shear, 12,000 pounds per square inch. Melting point, 1750 degrees F.

### Bronze or Gun-metal

This alloy consists of copper and tin. The best results for general use will be obtained by using alloys containing from 8 to 10 per cent of tin. This alloy is known as gun-metal. An increase of tin to over 20 per cent makes the bronze very hard and brittle. Bronze is used chiefly for castings, is much stronger than brass, and has the same corrosion-resisting qualities. Bronze is a poor conductor of electricity. It is adapted for use in bushings, small bearings, stuffing-boxes, covers, guards, linings, etc.

*Properties*—Cost, 25 cents per pound. Weight, 0.315 pound per cubic inch; 514 pounds per cubic foot. Specific gravity, 8.68. Strength: tension, 32,000 pounds per square inch; compression, 20,000 pounds per square inch. Melting point, 1800 degrees F.

### Non-gran Bronze

Non-gran bronze is a gun-metal alloy. Its composition is copper, 86.5 per cent; tin, 11 per cent; and zinc 2.5 per cent, with impurities which are less than 0.2 per cent. Non-gran bronze can be readily cast, and is also sold in bars 12 feet long. The solid sizes range from ½ inch to 5 inches in diameter, by eighths of an inch, and the cored sizes from ½ inch to 3 inches inside diameter, by eighths. It is a good metal for non-adjustable bushings where the original dimensions must be preserved through long service. It is also adapted, on account of its resistance to wearing action, for high-speed gears and worms, and for feed-nuts, valves, etc.

*Properties*—Weight, 0.31 pound per cubic inch; 536 pounds per cubic foot. Specific gravity, 8.6. Strength: tension, 37,000 pounds per square inch; compression, 19,500 pounds per square inch. Melting point, 2050 degrees F.

### Phosphor-bronze

Phosphor-bronze is an alloy containing copper, tin, and a small amount of phosphorus. It has greater strength and ductility than other simple bronze alloys, and can be cast, rolled, drawn cold, and forged. Phosphor-bronze is especially adapted for bearings and bushings where wearing qualities are desired, particularly for such parts as stuffing-boxes, linings, pump parts, propellers, etc. Its high elasticity makes it especially suitable for springs. It has a low electrical conductivity and a high corrosion resistance to salt water.

*Properties*—Cost, 25 cents per pound. Weight, 0.315 pound per cubic inch; 514 pounds per cubic foot. Specific gravity, 8.7. Strength, tension 60,000 pounds per square inch; shear, 60,000 pounds per square inch. Melting point, 1760 degrees F.

### Manganese Bronze

Manganese bronze is an alloy containing copper, zinc, and tin, with a small amount of manganese. It is stronger and tougher than phosphor-bronze, and has a high corrosion resistance. It is adapted for use in parts such as screw propellers, large gears, bearings, brake-shoes, etc. This material has taken the place of aluminum bronze, as it is more easily handled in the foundry and produces better castings.

*Properties*—Cost, 25 cents per pound. Weight, 0.315 pound per cubic inch; 514 pounds per cubic foot. Specific gravity, 8.7. Strength: tension, 65,000 pounds per square inch; compression, 120,000 pounds per square inch; shear 60,000 pounds per square inch. Melting point, 1600 degrees F.

### Tobin Bronze

Tobin bronze is an alloy containing from 59 to 63 per cent copper, from ½ to 1½ per cent tin, and the remainder zinc. Its resistance to the corrosive action of salt water and its non-liability to produce sparks under frictional contact are its chief characteristics. It is used chiefly for high-grade bushings, sleeves, valve parts, propellers, shaft bearings in contact with water, etc.

*Properties*—Cost, 25 cents per pound. Weight, 0.304 pound per cubic inch; 525 pounds per cubic foot. Strength: tension, 62,000 pounds per square inch; compression, 175,000 pounds per square inch; shear, 61,000 pounds per square inch. Melting point, 1600 degrees F.

### Aluminum

Aluminum is used chiefly on account of its low specific gravity. It is employed for small parts of the cast-iron class of castings which are not subject to shock or strain. It is also used as a substitute for copper wire on long spans. It is very ductile, and in proportion to its weight is as strong as a steel casting. On account of its high cost, its use is mainly restricted to small parts. Aluminum is highly resistant to all inorganic acids, except hydrochloric acid; alkalies cause it to corrode rapidly. Care must be taken to have the sections of the castings as nearly uniform in thickness as possible, so as to prevent molding cracks. Aluminum can be welded.

*Properties*—Cost, 30 cents per pound. Weight, 0.092 pound per cubic inch; 159.6 pounds per cubic foot. Specific gravity, 2.65. Strength: tension, 15,000 pounds per square inch; compression, 12,000 pounds per square inch; shear, 12,000 pounds per square inch. Melting point, 1218 degrees F.

### Monel Metal

Monel metal is an alloy of 60 per cent nickel, 38 per cent copper and a small amount of manganese or aluminum. It is tough and ductile and can readily be machined, cast, forged, annealed, rolled, soldered, brazed and welded. Monel metal is sold in rods, sheets, tubes or in cast form. It is used for parts requiring great strength, hardness and incorrodibility such as pump liners, valve seats, bolts, studs, shaft nuts and caps, nails, screws, chains, etc.

*Properties*—Cost, 40 cents per pound. Weight, 0.32 pound per cubic inch; 543 pounds per cubic foot. Specific gravity, 8.87. Strength: tension, 70,000 pounds per square inch; compression, 19,000 pounds per square inch; shear, 31,800 pounds per square inch. Melting point, 2480 degrees F.

### Babbitt

Babbitt is an alloy of tin and copper, containing small amounts of antimony. It is the most common bearing metal used with cast-iron boxes. When worn, it can be easily replaced by digging out the old lining and pouring a new bearing. There are a great many babbitting mixtures in use, each shop having its own standard, so that, if it is desired to make use of a particular grade, its composition should be specified.

*Properties*—Cost, 42 cents per pound (varies largely according to tin content). Weight, 0.263 pound per cubic inch; 450 pounds per cubic foot. Specific gravity, 7.29. Strength, tension, 4600 pounds per square inch. Melting point, 445 degrees F.

### Copper

Copper is used chiefly in wire and sheet form as a conductor of electricity. It is also adapted for tank linings, tubes, small hot-water boilers, oil systems, etc. It can be cast and rolled, and is hardened by drawing.

*Properties*—Cost, 16 cents per pound. Weight, 0.322 pound per cubic inch; 556 pounds per cubic foot. Specific gravity, 8.93. Strength: tension, 24,000 pounds per square inch; compression, 40,000 pounds per square inch; shear, 30,000 pounds per square inch. Melting point, 1940 degrees F.

### Zinc

Zinc is commonly used in sheets and wire, and is easily cast. It is used principally for tank linings, ornamental castings, models, galvanizing, etc.

*Properties*—Cost, 6.5 cents per pound. Weight, 0.250 pound per cubic inch; 430 pounds per cubic foot. Specific gravity, 6.9. Strength: tension, 5000 pounds per square inch; compression, 20,000 pounds per square inch. Melting point, 787 degrees F.

### Tin

Tin is chiefly used in sheet form for tank linings, etc., and as a covering for other metals.

*Properties*—Cost, 72 cents per pound. Weight, 0.263 pound per cubic inch; 455 pounds per cubic foot. Specific gravity, 7.29. Strength: tension, 3500 pounds per square inch; compression, 6000 pounds per square inch. Melting point, 450 degrees F.

### Lead

Lead is used principally in cast and sheet form. It is used for pipes, acid container linings, roofs and gutters, and weights. It has a high corrosion resistance.

*Properties*—Cost, 5 cents per pound. Weight, 0.41 pound per cubic inch; 710 pounds per cubic foot. Specific gravity, 11.37. Strength: tension, 2000 pounds per square inch. Melting point, 621 degrees F.

### Stellite

Stellite is an alloy containing cobalt chromium, and a small amount of molybdenum or tungsten. It is very strong, tough and hard, and a good resistant to abrasion and corrosion. Its chief use is for high-speed cutting tools, as it retains its cutting qualities even at red heat. Stellite cannot be machined, but must be cast and ground.

*Properties*—Cost, about $6 per pound. Strength: tension 110,000 pounds per square inch. Melting point, 3100 degrees F.

* * *

## OFFSET MILLING FIXTURE

For use in milling the faces *A*, Fig. 1, of bosses inside of the pistons of automobile engines, an offset milling fixture is used in the plant of the Studebaker Corporation, Detroit, Mich., which provides for the performance of this operation with very satisfactory results. The fixture is so clearly shown in the accompanying illustrations that only a brief description is required. It will be apparent that the fixture is supported by a bracket secured to the over-arm of a hand milling machine, and that the two side milling cutters are mounted in such a way that they have the required amount of overhang to reach into the piston to the faces which must be machined. Mounted on the arbor, which fits into the milling machine spindle, there is a sprocket wheel that carries chain *B* which runs over a second sprocket wheel mounted on the offset arbor between the two milling cutters. Before this fixture was designed, an attempt was made to make a similar equipment with a spur gear on the main arbor and a second gear on the offset cutter-arbor, but trouble was experienced through breaking the teeth of these gears in cases where the cutters encountered an exceptionally hard spot in a casting. With the sprocket chain, it is said that very satisfactory results are secured.

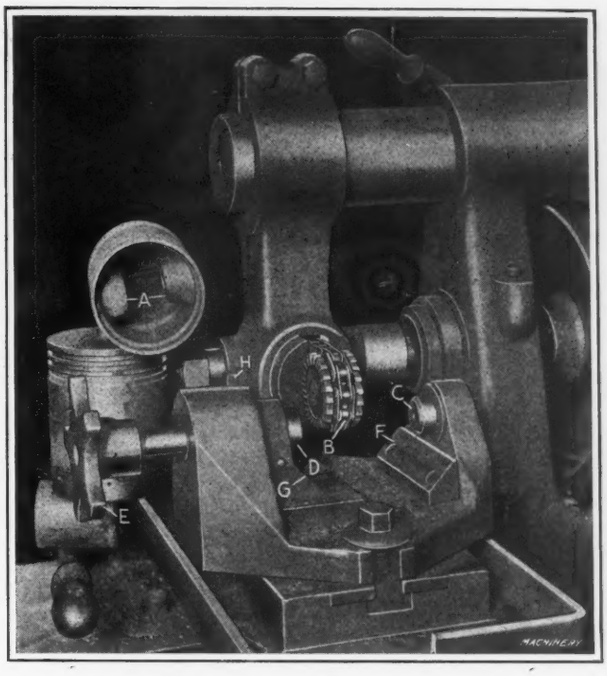



Fig. 1. Offset Milling Fixture used by the Studebaker Corporation for face-milling Bosses on the Inside of Pistons

For use in locating the work, it will be seen that there are two pilots *C* and *D*, the first of which occupies a fixed position, while the second is manipulated by a small pilot wheel *E*. It is also necessary to provide means of locating the piston in a horizontal position, which is accomplished by means of a beveled block *F*, that occupies a fixed position, and a sliding beveled block *G* on which pilot *D* is mounted. By turning the handwheel *E*, this sliding block *G* and the pilot carried by it are moved forward on a cross-slide so that the pilot enters the wrist-pin hole in the piston, and the tapered block pushes the piston over to provide for its horizontal location between blocks *F* and *G*. The lever which actuates the feed of the milling machine provides for feeding the work up to the cutters. Provision is made for taking up any slack which develops in the chain *B* by means of a screw *H*. This screw pushes forward the support on which the sprocket and milling cutters are mounted, thus adjusting the tension of the chain. E. K. H.

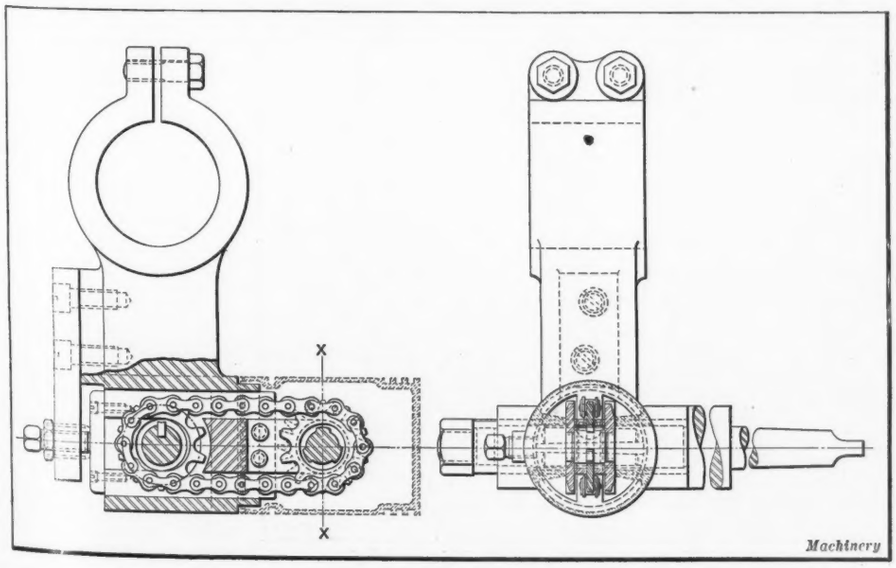
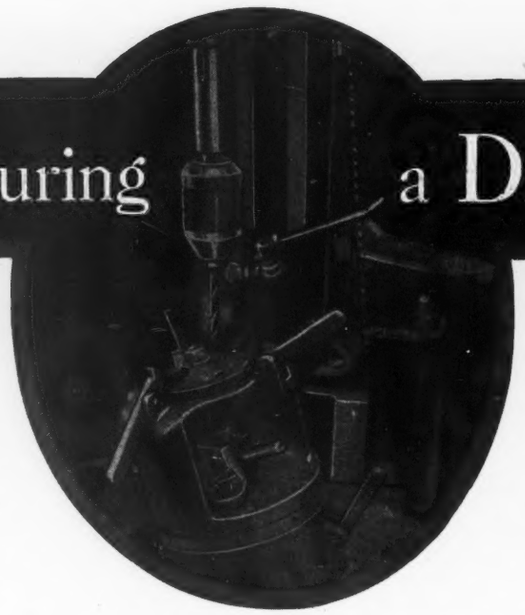



Fig. 2. Arrangement of the Mechanism of Offset Milling Fixture shown in Fig. 1

* * *

The making of phonograph motors has become a business in itself, and some factories are kept busy manufacturing motors for makers of talking machines, who manufacture the cabinets only.

# Manufacturing a Drill Chuck



## Some of the Methods Employed in Manufacturing a Semi-Automatic Drill Chuck and the Special Equipment that is Used

BY FRED R. DANIELS

SOME interesting methods and fixtures have been developed in the manufacture of the "Ettco" drill chuck, which is made by the Eastern Tube & Tool Co., Brooklyn, N. Y. Before describing the methods in detail, a general outline of the construction of the chuck and its principles of operation will be given. The main features of the chuck are that it may be operated without the use of a wrench of any kind and that it is self-tightening.

### Construction of the Chuck

Fig. 1 shows the parts of the chuck that require special machining operations, as well as an assembled view, and Fig. 2 shows a disassembled view, in which all the parts of the chuck may be seen. The three jaws *P*, Fig. 1, hold the drill shank securely when the chuck is turned, by reason of the teeth in the end of the jaws engaging the thread on cone *K*. This cone is bored for shank *J* and has a collar *R* by means of which the cone is supported on the buffer spring *H* (see also Fig. 2) and which forms the seat for the ball bearing *G*. When the body *N* with its cap *A* is revolved about the stationary cone screw, it is obvious that the three jaws will operate, traveling in their respective holes and at an angle of 15 degrees from the vertical. The lower end of the cone screw has a pilot *L* which serves to exclude dirt from the threads and the inner part of the chuck. Without proceeding further, it should be evident that in order for the jaws to function properly, or at all, the holes *M* must be accurately machined and must be parallel with the pitch line of the threads and, incidentally, with the sides of the tapered hole that contains the accurately fitted cone (see view *E*, Fig. 1). The boring of the holes *M*, which must be equally spaced as well as accurately finished, involves the use of special equipment, if the work is to be produced in quantity. A description of this equipment will be given later.

As a means of preventing the jaws from turning in their respective holes, two special cuts *S* as shown at *C*, Fig. 1, are taken in each jaw, forming a sort of key in back of the teeth. These keys ride in arc-shaped keyways in the body and take the torsional strain produced on the jaws in driving the drill while it is at work. The shape and location of these keyways and also of the jaw key may be readily seen by referring to Fig. 2 at *T*. The same degree of accuracy as is used in boring the jaw holes must also be employed in machining both the jaw keys and the keyways.

The thrust ball bearing *G* is housed between the collar of the cone and the inside wall of the cap, and takes the working thrust. It consists merely of two annular raceways which enclose chrome-nickel steel balls. Another operation deserving special attention is that of cutting the threads on the cone screw, for which a special thread milling machine was built, which will be described later. No further description of the operation of the chuck should be necessary; however, it should be stated that any dimensions appearing either in the article or on the illustrations apply to the smaller of the two sizes of chucks now being commercially manufactured, namely the No. 2 size, which is capable of taking a 25/64-inch shank.

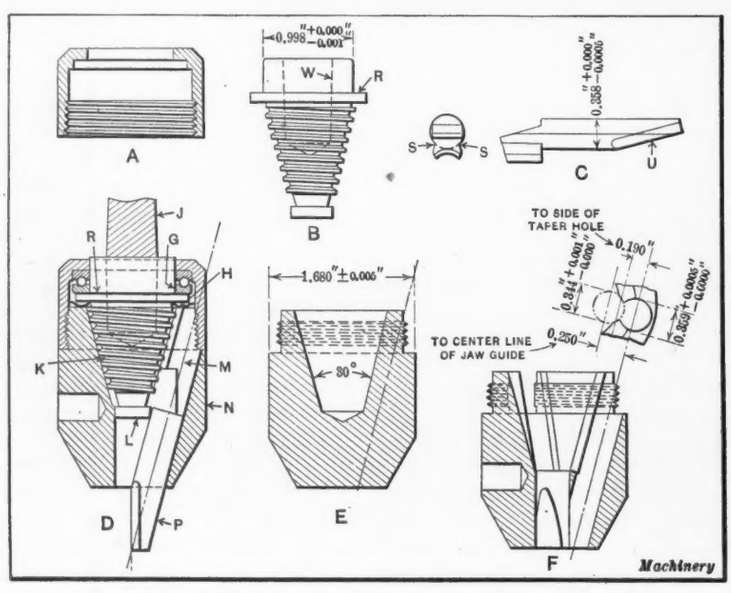



Fig. 1. An Assembled View of the Chuck, and Principal Details in Various Stages of Completion

### Making the Jaws

The jaws shown at *C*, Fig. 1, are made from 0.50 per cent carbon chrome-nickel steel. When the manufacture of the "Ettco" chuck was first attempted, it was found that the toughness of the steel caused much trouble in performing the first operation—that of centering the blanks. Many drills were broken, and the best centering tools obtainable did not speed up production sufficiently nor produce a smooth center. After some experimenting, this operation was finally performed by punching the centers in a Bliss power press. A simple clamping fixture was designed for holding the work in an upright position while performing the centering, and as a result, jaws are being centered in quantity and with a much cleaner center than was formerly produced.

The operation of milling the 120-degree section *B* at one end of the jaws is performed on a Garvin milling machine equipped with a simple holding fixture as shown in Fig. 3. The work is located at an angle of 15 degrees in an angle-block *A* which is held in an ordinary milling vise. Two 60-degree milling cutters are used for this operation. The condition of the jaws as they appear before and after milling may be seen by referring to the illustration, where sev-

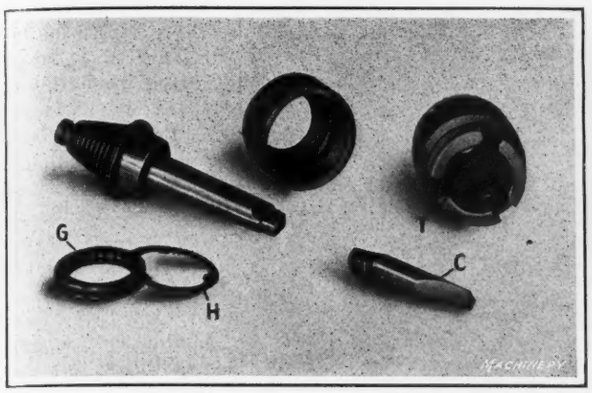



Fig. 2. View of Disassembled Chuck, showing the Various Parts

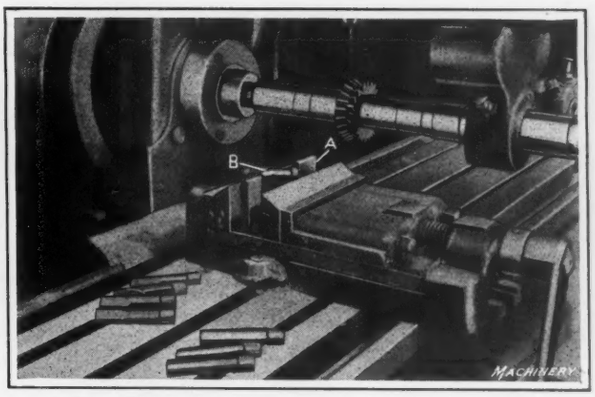



Fig. 3. Milling the 120-degree Angle Section on the Jaws

eral jaws are shown on the machine table. Fig. 4 shows the operation of milling the projecting integral key section previously referred to. Two pieces are machined at a time, the work being held in the fixture by means of the button *A* which binds the jaws against the stops *B* when the knob *C* is tightened. Two forming cutters *D* are employed and these should always be kept in good condition, because each jaw must satisfy the requirements of the two-hole working ring gage *E*.

For cutting the 8-pitch left-hand Acme threads in the end of the jaws which engage the thread on the cone screw, a fixture for holding six pieces, or two sets of jaws, at a time is used. The thread angle is 1 degree 45 minutes, the teeth being first rough-cut and then hobbed. The hob is a duplicate of the cone screw with which the jaws are to operate in the chuck, plus 0.010 inch clearance. After milling the threads, each jaw of each set is marked successively with numbers; thus the three jaws constituting the first set would be marked 1, 2, and 3, respectively. This facilitates assembling in that it enables the jaws to be put into the jaw holes of the body in the correct sequence, so that with the ends of the jaws even, the threads will mesh properly with those on the cone screw. After the jaws have been hardened, the cylindrical section is ground to 0.358 inch diameter with a tolerance of −0.0005 inch, which allows a maximum clearance of 0.001 inch after the jaws are assembled in the body as shown in Fig. 1, at *C* and *F*.

### Machining the Jaw Holes

The body of the chuck is machined from solid bars of a 0.020 per cent carbon alloy steel containing manganese, chromium, and nickel. The first operation is performed on a No. 2A Cleveland automatic and the work, each diameter of which is held to a concentricity limit of 0.001 inch, is shown in Fig. 1 at *E* as it appears after this operation. The tapered hole which houses the cone is bored to a 30-degree included angle and held to a close gage fit. One of the most interesting operations performed on the body is shown in Fig. 9. It consists of machining the jaw holes on a turret lathe and requires the use of a special indexing fixture, as shown in Fig. 7. The base *A* of the fixture is fastened by machine screws to the lathe faceplate and carries the balance weight *B* on one side, and the holding and clamping arrangement on the other side. These parts are attached to the base hub *C*, which is located at an angle of 15 degrees, the arrangement being clearly shown in the illustration. The cone center plug *D* is carried in the index-plate *H*, the hub of which revolves in a hole in the fixture hub

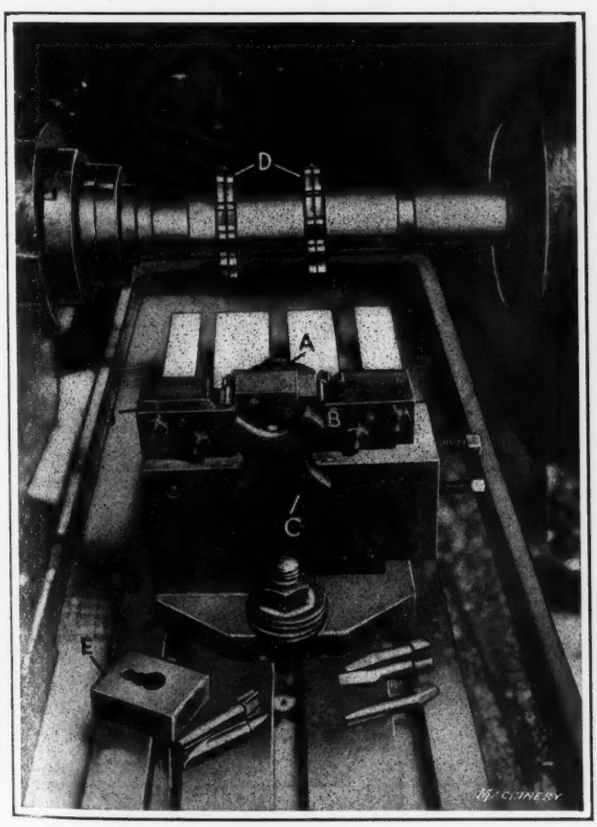



Fig. 4. Milling the Key Sections in the Jaws. For this Operation Two Pieces are held in the Fixture at One Time

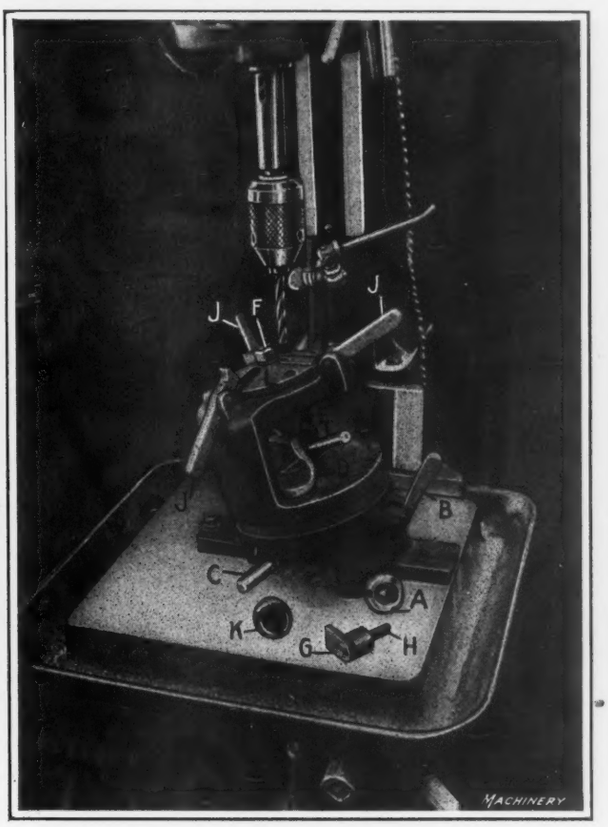



Fig. 5. Drill Jig for Use in drilling the Jaw Guide Keyways. This Jig may be revolved when indexing the Work

so that both the plug and the work *E* may revolve with the index-plate. The work is clamped in position by means of the clamp nut *F* which is adjustable in the plate *G*. This plate is hung to the index-plate *H* by means of three studs *J*. The index-plate is held in position when the work is in place, by means of the arresting collar *K* screwed to the hub of the fixture, which has three equally spaced index holes machined in it with which the plunger *L* engages when indexing the work.

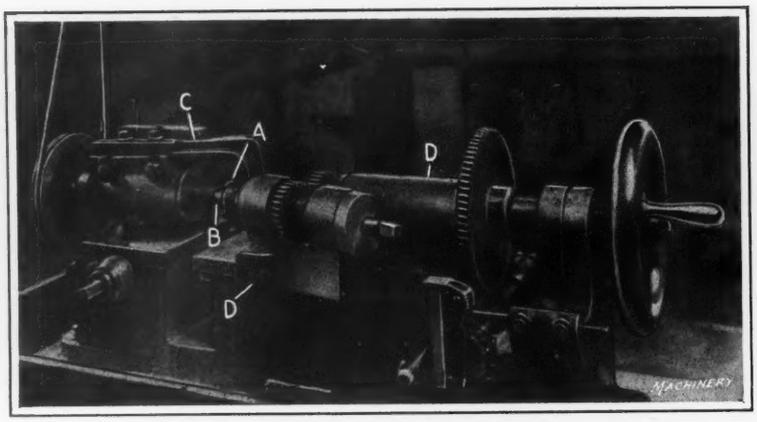



Fig. 6. The Cone Screw Thread Milling Machine

The operation of the fixture is as follows: The work is first placed on the cone *D* and the plate *G* carrying the nut *F* is slipped over the studs *J*, and then turned clockwise as far as the studs will allow. The three key holes *M* allow the plate to be placed in position without removing the studs. The clamping device is then revolved on its 15-degree center until the spring-actuated plunger *L* enters the hole in the index-plate, after which the arresting collar *K* is tightened by means of handle *N*, thus clinching the index-plate to the face of the fixture hub and clamping the nut *F* securely against the nose of the work. In performing the operation, each hole is machined separately, the indexing plunger then being withdrawn, the arresting collar loosened, and the work indexed 120 degrees, as determined by the holes in the index-plate. The position of the pin *P*, by means of which the indexing plunger is withdrawn, may be seen in Fig. 9 at *A*. The jaw hole is first centered and drilled out with a 21/64-inch drill, after which a single-point boring tool *B* is run through; on account of the required length of the tool, the latter operation is repeated so as to correct any possible irregularity which might result from the tool springing during the first cut. The hole is finally reamed to 0.359 inch in diameter.

### Machining the Jaw Guide Keyway

After the jaw holes are drilled in the body, a thin wall of metal remains between the tapered hole and each of the jaw holes which may be seen at *A*, Fig. 5, and through which a hole forming the keyway for the jaw guide is drilled, as shown at *T*, Fig. 2. This operation, the set-up for which is shown in Fig. 5, offers an especially trying test for the drill chuck, for a more unstable area in which to drill could hardly be imagined. The action on the drill is very harsh, transmitting a suddenly applied torsional strain to the chuck with every revolution of the spindle. The chuck shown in the illustration has withstood this kind of service without repair for more than four months. The indexing drill jig is strapped to the drilling machine table as shown, the base casting having a face which is at an angle of 15 degrees with the machine table, and on which the upper part of the jig may revolve. The construction of the indexing part is similar to that of the turret lathe indexing fixture previously described. The handle *B* controls the indexing device which may be locked by means of the handle *C*. The work is located between the support *D* and a cone secured by means of nut *F* to the under side of the bushing plate *L* and is clamped in place by means of the cam-lever *E*, which operates an eccentric cam mounted in the support *D*.

The locating cone is provided with clearance holes or slots of the proper size and shape and parallel to its taper. These slots form a guide for the drill, preventing it from running in toward the tapered hole in the body. The bushings *G*, of which there are three, fit tightly into the bushing plate; and the lower end *H*, which fits into the jaw hole, has a curved clearance cut as shown, so as to prevent the path of the drill from being diverted toward the jaw hole. Thus the slots in the locating cone and in the bushing come together when the bushings are in place, forming a complete and positive guide for the drill and maintaining the parallelism between the jaw holes and the sides of the tapered hole, which the accuracy of the chuck demands. The bushings are removed from the jig when it is being reloaded, by means of the handle levers *J*.

The work as it appears after drilling is shown at *K*, from which it will be seen that the interior is very ragged; this condition is caused by the jaw guide hole just drilled breaking into the jaw body hole. The finishing of these holes is performed by broaching, the work being done on an arbor press. Reaming was found to be impracticable on account of the nature of the holes. A regular round broaching tool is used on the hole proper, while for cleaning the burrs formed on the ridge where the two holes meet, a special

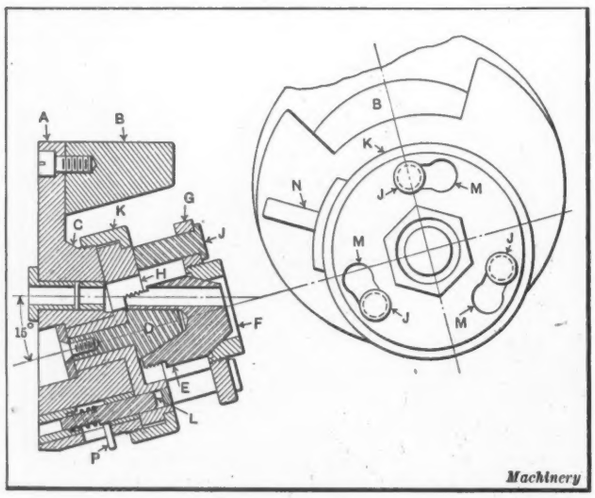



Fig. 7. Sectional View of Indexing Fixture used on Turret Lathe, as shown in Fig. 9

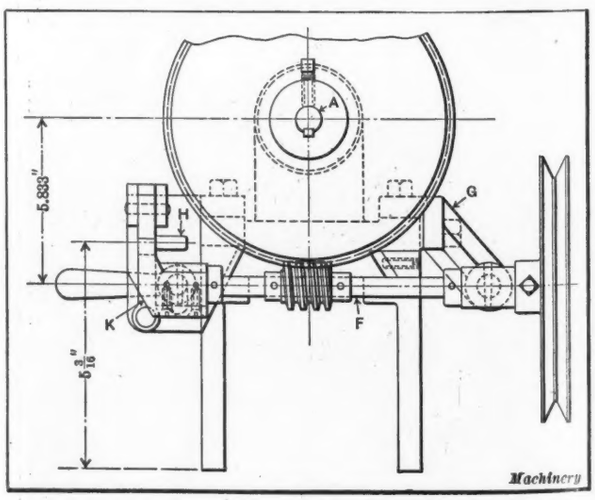



Fig. 8. End View of the Thread Milling Machine for milling Threads on the Cone Screw

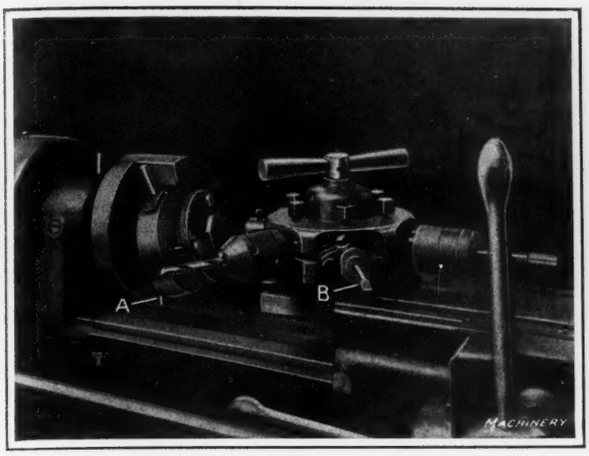



Fig. 9. Turret Lathe with Special Fixture for machining Jaw Holes

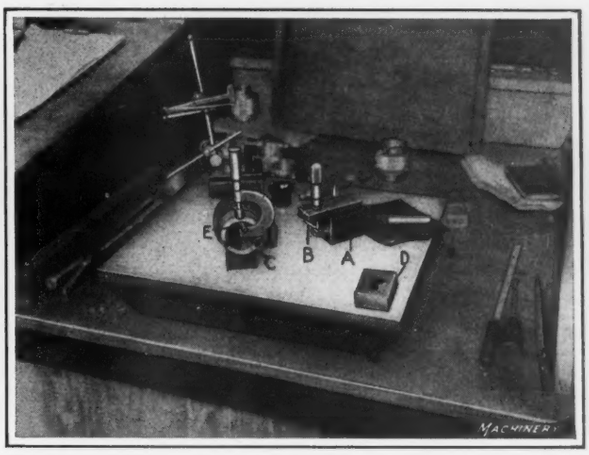



Fig. 10. Inspector's Bench and Gages for testing the Various Parts

broaching tool is employed. Reference to view *F*, Fig. 1, shows the relation between the holes, as well as some important dimensions and also gives a good idea of the difficulty of performing these operations.

### Milling the Threads on the Cone Screw

The finished tapered cone screw is shown in Fig. 1 at *B* and also assembled with the shank in Fig. 2. It is made of the same special alloy steel of which the body and the cap are made and all diameters must be concentric to within a limit of 0.001 inch. The shank hole *W* has a No. 5 Jarno taper, which is machined on a hand screw machine equipped with a taper attachment of the usual design.

For cutting the left-hand Acme threads on the cone screw, the special thread milling machine shown in Fig. 6 was designed by the engineers of the Eastern Tube & Tool Co. The illustration shows the cutter *A* at work on the screw *B*. Fig. 11 is a plan view of the machine with the center support *C*, Fig. 6, removed, while Fig. 8 is an end elevation with the master screw, nut, handwheel, etc., removed. It will be seen that the screw spindle *A* is worm-driven and carries an 8-pitch left-hand thread master screw *B*, Fig. 11, keyed to it, and a 29-tooth bevel gear *C* for driving a similar bevel gear on the work-spindle *D*. The master screw revolves in a brass nut *E* which is attached to the base and which may be readily replaced when necessary as, for instance, when a thread of different pitch is required. The screw-spindle, as well as the work-spindle, is furnished with suitable radial thrust ball bearings properly housed in the slide, as shown at *D*, Fig. 6. The work and the cutter are shown in dot-and-dash lines in Fig. 11, set in the proper position for starting the cut. The construction of the cutter-spindle mountings is almost identical with that of the work-spindle, which is clearly shown in section. The traverse of the slide or carriage is to the right, carrying with it the drive, feed, etc. The pulley end of the worm-shaft *F*, Fig. 8, is supported in a swivel bearing in bracket *G*, and the opposite or feed end has a bearing in the feed-control latch *K*. When the traverse of the slide brings the stud *H* in the locking lever into contact with the stop *J*, Fig. 11, the latch is released, allowing the worm-shaft to drop into pocket bearings and stopping the feed. Fig. 6 shows the feed disengaged.

The tapered hole in the work permits it to be driven onto the tapered end of the spindle, from which it may be removed by means of nut *L*, Fig. 11. It will be noted that a micrometer adjustment is provided for sinking the cutter to the proper depth, the position of the cross-slide *N* being regulated by handle *M*. The cutter revolves at a rate of 220 revolutions per minute while the work-spindle is geared down to 1¼ revolution per minute. The time required to cut the thread on the cone screw is about eight minutes. A left-hand Acme thread, having an angle of 30 degrees between the sides, is cut in the blank to a depth of 0.078 inch, or 0.0055 inch deeper than the normal depth of an 8-pitch Acme thread. This allows for grinding the cone after the thread is cut, so as to fit the tapered hole in the body.

### Heat-treatment, Grinding, and Inspecting

The jaws and cone screw receive a special heat-treatment consisting of carburizing by heating to 1650 degrees F.;

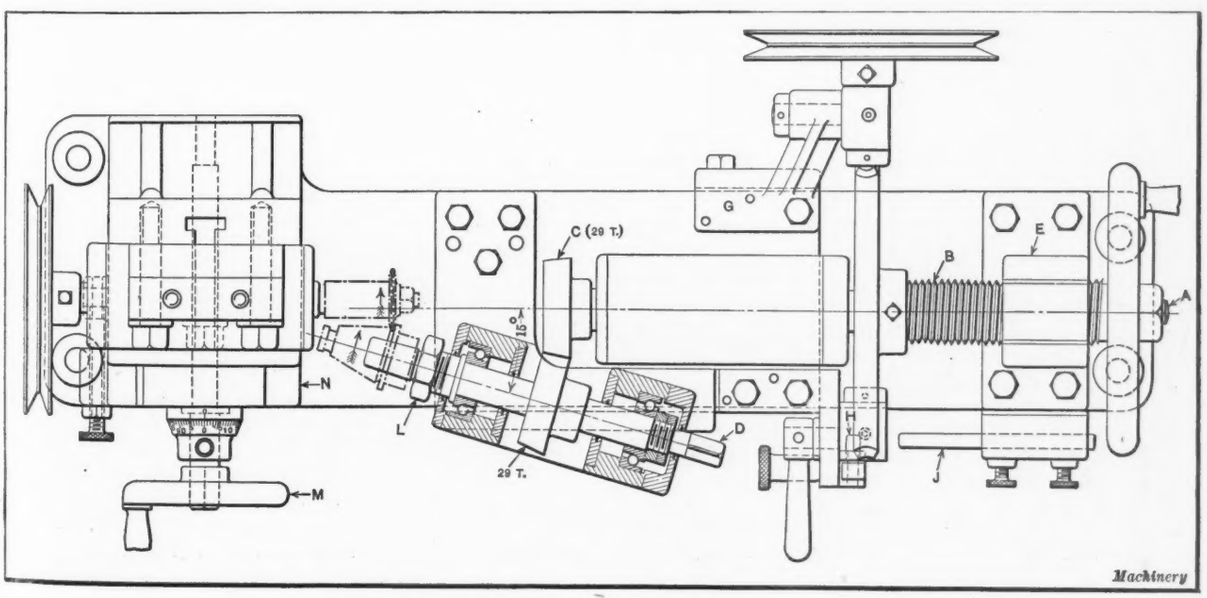



Fig. 11. Plan View of the Thread Milling Machine shown in Fig. 6

hardening by heating to 1450 degrees F., and quenching in oil, and then by heating to 1320 degrees F., and quenching in water; and finally tempering by heating to 375 or 400 degrees F., for a period of ten minutes. The grinding operations follow the heat-treatment, and all fitting parts such as the cone screw, collar and hub, and the cylindrical part of the jaws are held to a very accurate gaging fit. The body of the chuck below the knurled surface, as well as the cap above its knurled surface is also ground for finish. A view of the inspector's bench is shown in Fig. 10. The micrometer-head gage *A* is used in connection with a wire *B*, 0.072 inch in diameter, for measuring the threads on the jaws. A similar type of gage is also employed for measuring the grooves *S*, Fig. 1, which form the key sections. The inspector's gage for gaging the jaw body integral key is shown at *D*, Fig. 10, while at *C* is a set-up illustrating the method of measuring the thickness of the wall left between the jaw holes and the tapered holes in the body after the jaw holes have been machined. This measurement must, of course, be made before the jaw guide keyways are drilled. The measurement is obtained by the use of a ball-point micrometer set in the hole as shown, measuring over a plug gage *E* 3/16 inch in diameter. It will be seen by referring to the dimensions in Fig. 1 at *F*, that this measurement for a No. 2 chuck would be the sum of the plug gage diameter, 0.1875 inch and the thickness of the wall 0.0105 inch, or 0.1980 inch with an allowable tolerance of 0.00025 inch. For taking lengthwise measurements on the cone, limit gages are used, and for the hub which extends through the cap as well as for the hole in the cap itself, concentricity gages are used, the work being held to a limit of 0.001 inch.

### Final Operations

In assembling, a 1/64-inch flat is ground on the jaws at *U*, view *C*, Fig. 1, after which the numbered jaws are set into the holes in the proper sequence, the lower ends resting on a surface plate. The cone screw is then screwed in until it rests on the interposed buffer spring as shown in the assembled view *D*, Fig. 1. The ball bearing is now placed in position and lubricated, after which the parts are enclosed by assembling the cap. A quick clamping fixture is used to screw the cap tightly into place, after which the chuck is knurled with a coarse knurling tool for a distance of about 1/2 inch on both sides of the joint. This closes the joint so that the body of the chuck has the appearance of being a solid piece and makes it impossible to open it except by the use of special equipment. Standard Morse taper shanks, as specified, are furnished with the chuck and are pressed into the tapered hole of the cone. No wrench of any kind is furnished with the chuck but it will be noticed that three deep holes are provided in the body, which may be used to tighten the chuck by means of any convenient piece of stock in cases where the work revolves instead of the drill; otherwise the strain of the tool itself will tighten the chuck.

* * *

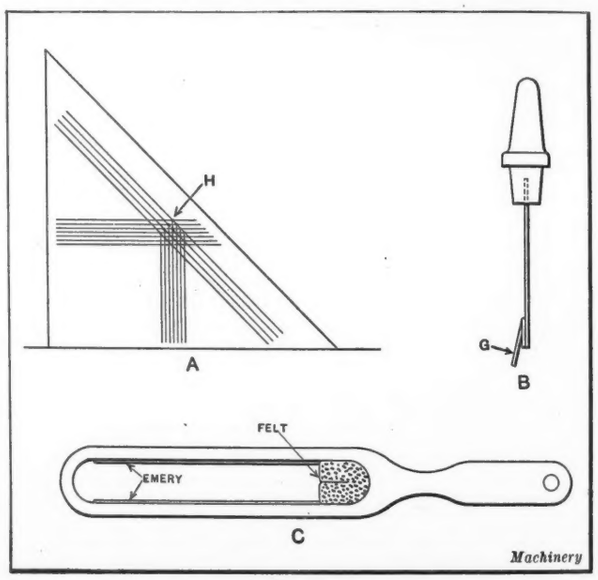
## DEVICES FOR USE IN THE DRAFTING-ROOM

The section liner shown at *A* consists simply of a regular 45-degree celluloid triangle that contains any suitable number of small drill holes, as for instance, sixteen. These holes are laid out about 1/16 inch apart on lines parallel to the hypotenuse, which are scribed about 1/16 inch apart. This arrangement forms a quadrilateral of holes as shown at *H*. The drill holes should be large enough to allow the insertion of the point of a pencil. They should, of course, be laid out and drilled evenly, using a drill that is not larger than No. 48. The manner in which the triangle is used is no doubt apparent. It will be seen that by inserting the pencil point into a hole and sliding the triangle along a straightedge, and then using the next hole on the side of the quadrilateral, and so on, absolutely even sectioning can be obtained.

After four lines have been drawn in this manner, the position of the triangle may be changed an amount equal to the distances between three lines, taking care that the first two scribed lines of the triangle coincide with the last two drawn lines; then two more lines are drawn, using the holes in order, and so on. If wider section spaces are desired, use the holes on the diagonals of the quadrilateral instead of on the sides, proceeding as before.

Ink bottles are frequently upset in the drawing-room, causing much annoyance and often doing needless damage. A holder for the bottle can be easily made from a spoiled bevel gear having a hub large enough to be bored out to hold the bottle. The hole should not be bored clear through, as a shoulder must be left on the inside to form a seat for the bottle. If the hole is bored sufficiently large, a narrow strip of blotting paper may be wound around the body of the bottle to hold the bottle firmly and at the same time absorb any ink which runs over.

At *B* is shown an ordinary ink bottle stopper with the quill removed and a piece of wire substituted. This wire has a coil or two wound at the end, with the extremity of the wire *G* extending as shown. This idea was employed by




Simple Devices for Use in the Drafting-room

a draftsman who had experienced trouble with the quill arrangement. When the ink bottle is full, it is usually found that a quantity of ink is delivered to the pen which is much larger than required. This is undesirable because the pen will require frequent wiping on account of the ink drying in the pen before the excessive supply is completely consumed. Then again, a large supply of ink in the pen is likely to affect the quality of the lines. The coils at the end of the wire will carry just about enough ink to supply the pen properly, and this arrangement also has an advantage over the quill in that it may be used with equal success when the bottle is nearly empty or full. The end of the wire *G* is drawn between the bows of the pen, the ink running down the wire into the pen.

The pencil pointer shown at *C* consists of a piece of wood shaped with a handle and an opening as shown. The inside walls of the opening are covered with a medium grade of emery or emery cloth, and a piece of thick felt is inserted at one end. The felt is used to wipe the graphite from the pencil lead after it has been pointed, and may also serve as a pen wiper, thus making a combination pencil pointer and pen wiper, which may advantageously be included in a draftsman's equipment. F. R. D.

* * *

A firm in Swansea, England, is reported to have purchased twenty-five German submarines which are to be broken up and sold for scrap metal. It is claimed that the "break-up" value of each vessel is approximately $12,000.

# Making the Timken Roller Bearing

By Edward K. Hammond

## Methods of Heat-treating, Machining and Inspecting—Second of Two Articles

FOR grinding the bearing surface on the rollers used in Timken roller bearings, a plain Brown & Sharpe grinding machine is employed which is equipped with some very interesting auxiliary attachments, as illustrated in Fig. 14. The rollers to be ground are placed in a feed chute *A*, after which the entire operation of the machine is automatic. Running along the front of the machine there is a camshaft *B*, and as successive rollers reach the end of the feed chute, cam *C* and pivoted lever *D* operate a push-rod *E* which has an oscillatory movement back and forth in a horizontal direction parallel to the ways on the machine. As a result of this movement, push-rod *E* strikes the end of successive rollers as they come down chute *A* and pushes them between a pair of spring fingers carried at the front of cross-slide *F* which also receives an oscillatory movement from a cam-actuated mechanism receiving motion from shaft *B*. After the roller is pushed between the spring fingers, advancement of the slide *F* causes the roller to be carried forward to a position between the centers on the grinding machine where it is automatically gripped and held in the proper position for grinding. It will be seen that at the right-hand end of shaft *B* there is a cam *G* and link mechanism *H*. By means of motion transmitted from this mechanism through a suitable system of links, provision is made for withdrawing the tail-center from the roller on which the grinding operation has just been completed. As a result, this roller drops into a chute which delivers it into a receiver provided for that purpose. At the same time, a fresh roller is advanced by slide *F* to a position between the centers, and at this time cam *G* and its auxiliary mechanism releases the tail-center so that the spring against which it has been pulled back may advance the center into contact with the roller held between spring fingers on the cross-slide. In this way the roller is gripped between centers ready for the grinding operation to be performed.

Fig. 14. Grinding Rollers on a Plain Brown & Sharpe Grinding Machine equipped with a Special Magazine Feed Mechanism

### Automatic Machines for Gaging Rollers

In order to obtain satisfactory service from any form of roller bearing, it is of the utmost importance to have all of the rollers in the bearing of exactly the same size. A very brief consideration will suffice to make it apparent that if any of the rollers in the bearing are larger than other rollers, it will be the over size ones which will have to carry all of the load, because they will prevent engagement between the raceways and smaller sized rollers. The manufacture of roller bearings is, of course, a quantity-production proposition, and on this account it would not be feasible to attempt to hold dimensions of the work between very close limits of accuracy. This condition, combined with the necessity of having all rollers in a bearing of the same size, has led to the adoption of an expedient which has proved very satisfactory. Both the inner and outer raceways and the rollers are graded according to size, with the final result that they are sorted out into fifteen standard classes which vary from the specified size by −0.00175 inch, −0.00150 inch, −0.00125 inch, −0.00100 inch, −0.00075 inch, −0.00050 inch, −0.00025 inch, O. K., + 0.00025 inch, + 0.00050 inch, + 0.00075 inch, + 0.00100 inch, + 0.00125 inch, + 0.00150 inch, + 0.00175 inch. It will be evident from these figures that the size of each standard class of

TABLE 3. MACHINING AND INSPECTING OPERATIONS ON ROLLERS OF TIMKEN ROLLER BEARINGS

| Operation Number | Name of Operation | Type of Machine Used | Type of Tools Used |
|---|---|---|---|
| 1 | (a) Feed stock and rough-form | National-Acme automatic | Stop in first position and forming tool on front slide |
| | (b) Center | National-Acme automatic | Center drill in second position |
| | (c) Finish-form | National-Acme automatic | Forming tool on overhead slide |
| | (d) Cut off | National-Acme automatic | Cut-off tools on rear slide |
| 2 | Gage samples at machines | | Special gages |
| 3 | Mill off teat left by cut-off tool | Special milling machine | Milling cutter |
| 4 | Complete visual inspection | | |
| 5 | Carburize and heat-treat | Gas-fired furnaces | Pyrometers, etc. |
| 6 | Complete visual inspection | | |
| 7 | Grind bearing on rollers | B. & S. plain grinding machine | Magazine feeding attachment |
| 8 | Complete visual inspection for cracks and tool marks | | |
| 9 | Tumble in chamois leather | Abbott tumbling barrels | Shredded chamois leather |
| 10 | Gage for taper | Automatic taper gaging machine | |
| 11 | Gage for diameter | Automatic diameter gaging and sorting machine | |

*Machinery*

TABLE 4. POWER PRESS AND INSPECTING OPERATIONS ON RETAINERS OF TIMKEN ROLLER BEARINGS

| Operation Number | Name of Operation | Type of Machine Used | Type of Tools Used |
|---|---|---|---|
| 1 | Blank and cup | No. 74 Consolidated power press | Combination blanking and drawing die |
| 2 | Size and pierce | No. 6 Consolidated inclinable power press | Combination drawing and piercing die |
| 3 | Taper and flange | No. 6 Consolidated inclinable power press | Drawing die |
| 4 | Trim outside diameter of flange | No. 6 Consolidated inclinable power press | Trimming die |
| 5 | Bell-mouth | No. 3-A Bliss power press | Bending die |
| 6 | Form small flange | No. 56 Toledo power press | Bending die |
| 7 | Perforate | No. 2-A Bliss power press | Piercing die with index attachment |
| 8 | Wing | No. 2-A Bliss power press | Bending die with index attachment |
| 9 | Spread for assembling | No. 21 Bliss inclinable power press | Tapered punch and die |

*Machinery*

roller or raceway differs from the next class by 0.00025 inch. Each of these fifteen standard classes may be further sorted out into four sub-classes which are designated by the standard class number followed by a letter A, B, C, or D to designate the exact sub-class to which the roller or raceway belongs. Hence, it will be apparent that the rollers or raceways may be finally sorted out into sixty different classes where the most extreme accuracy is necessary.

After this sub-division of the product has been made, it is not only an easy matter to select a set of rollers for a bearing, which are all of exactly the same size, but these rollers are also assembled into raceways of corresponding size, so that the most desirable condition of fit is obtained. For instance, a cone or inner raceway which is 0.00175 inch over size would be assembled with a set of rollers which are 0.00175 inch under size, so that the deviation of the rollers from the specified diameter compensates for the error in the diameter of the raceways. By following this practice, the user of the bearings not only secures the improved running properties of a bearing where all the rollers are of the same diameter, but he also obtains the most desirable condition of fit between the rollers and raceways.

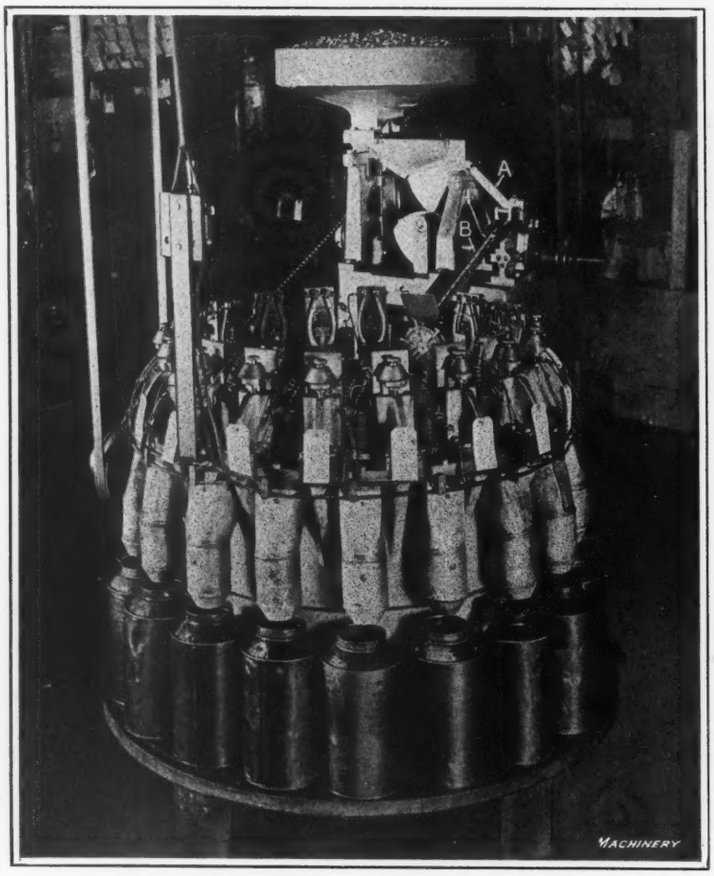



Fig. 15. All Rollers in a Bearing must be of exactly the Same Size. This Machine automatically grades Rollers to Fifteen Standard Sizes, which are further sorted out into Sixty Sub-sizes

Automatic machines have been developed by engineers of the Timken Roller Bearing Co. for use in automatically gaging the rollers and sorting them into the sixty different sizes to which reference has been made. One of these machines is shown in Fig. 15, from which it will be seen that there is a hopper at the top into which rollers are dumped, and after this supply of rollers has been provided, the operation of the machine is entirely automatic. Before starting to explain the way in which this machine gages and sorts the rollers, attention is called to an interesting feature of the mechanism provided for delivering rollers from the main feed hopper into the machine. From the main hopper it will be seen that there is a chute *A* through which the rollers run in order to reach chute *B* which carries them into the machine. Attention is called to the fact that all of the rollers which will be seen in chute *B* are running with the small end of the taper downward. This is not a posed picture; it represents the way in which work is actually fed to the machine. At the junction point between chutes *A* and *B* there is a mechanism which automatically adjusts the position of the rollers so that they all enter chute *B* with the small end down. Regardless of which way a roller runs down chute *A*, it reaches the top of chute *B* and is moved forward by a pusher which brings the large diameter of the roller into contact with a bar that is held down by a compression spring of low tensile strength. Continued advance of the pusher, which engages the roller at a point midway between its two ends, results in swinging the roller about its large end, which is in contact with this bar, so that

the roller eventually enters chute *B* with the small end of the taper downward.

After leaving chute *B*, the rollers are carried around a track at the top of the machine, which runs over a series of chutes leading down to containers placed to receive rollers of the different gaged sizes to which reference has already been made. The way in which the machine operates is as follows: Over the top of each delivery chute there is a small trap door which is normally held in the closed position by means of an electromagnet. The containers are arranged to receive rollers from 0.005 inch over size in consecutive order down to rollers 0.005 inch under size, and as the rollers reach the trap doors leading to the receptacles placed under the track, electrical contact to control the operation of the electromagnet is made by having the roller run under a brush placed above the track. It will at once be apparent that if the roller is too small, it fails to engage the brush and as a result the electrical connection is broken, thus releasing the electromagnet and allowing the trap door to drop open, with the result that the roller passes through into the receiver containing rollers of its own exact size. As the next roller comes along, if it is of sufficient size to engage the brush, the electrical circuit is once more restored and the trap door is closed before the roller reaches the door, with the result that this roller passes on over. By having the machine arranged with sizes decreasing gradually from the maximum to the minimum size which is allowable for the rollers, it will be apparent that each roller continues its course around the track of the machine until it finally

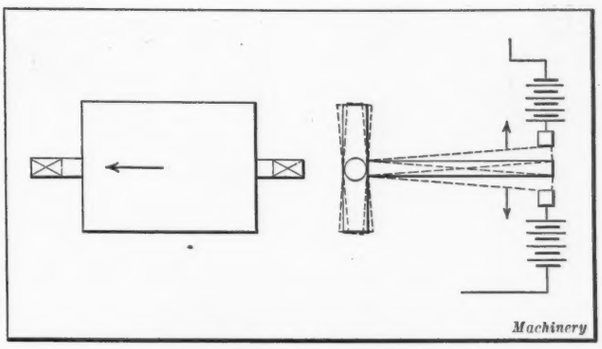



Fig. 16. Detail of Electrical Control Mechanism for opening Rejection Trap on Machine shown in Fig. 22

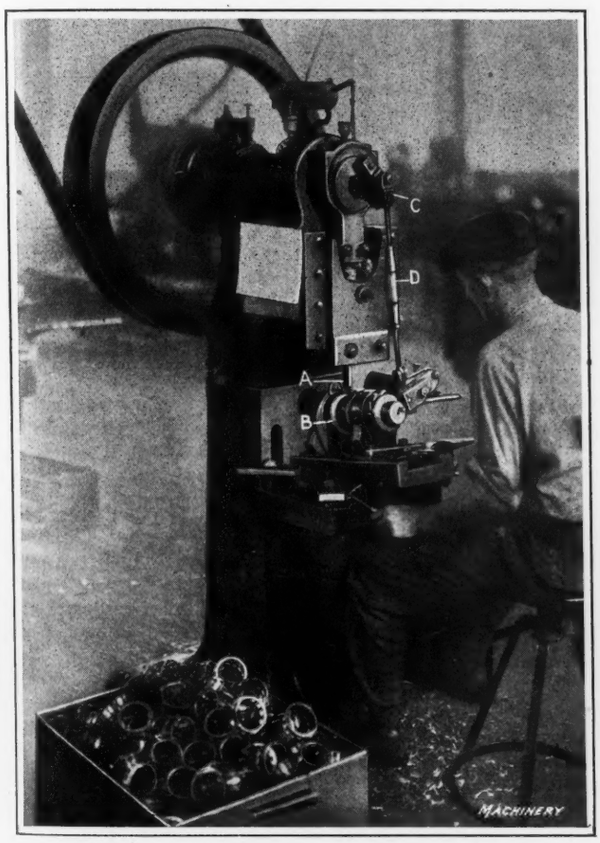



Fig. 17. E. W. Bliss Power Press equipped with Indexing Die used for performing Piercing Operation

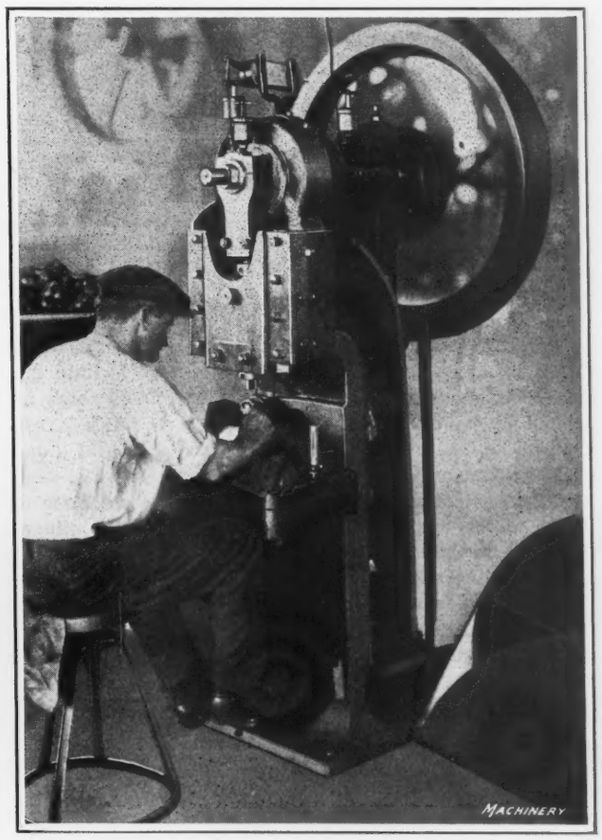



Fig. 18. E. W. Bliss Power Press equipped for bending up the "Wings" on the Roller Bearing Retainers

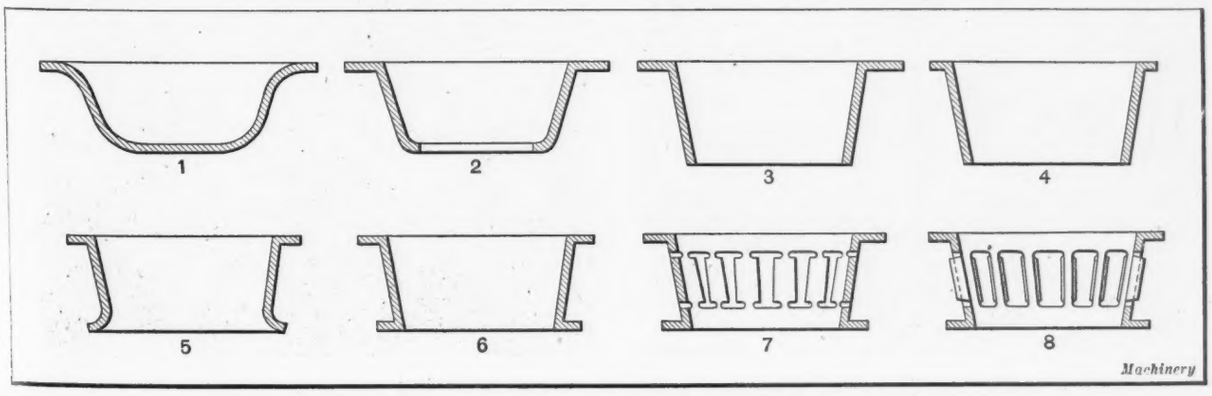



Fig. 19. Condition of Cage or Retainer after Each Successive Step in the Process of Manufacture

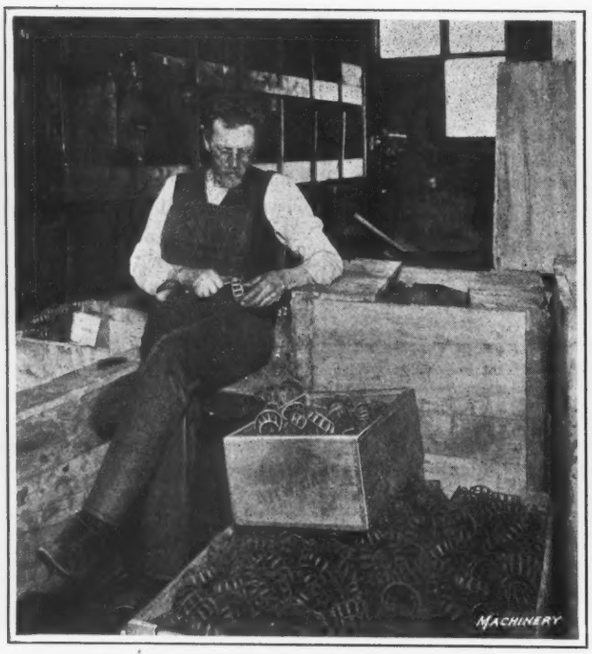



Fig. 20. Each Retainer receives a Complete Visual Inspection before being sent to the Assembling Department

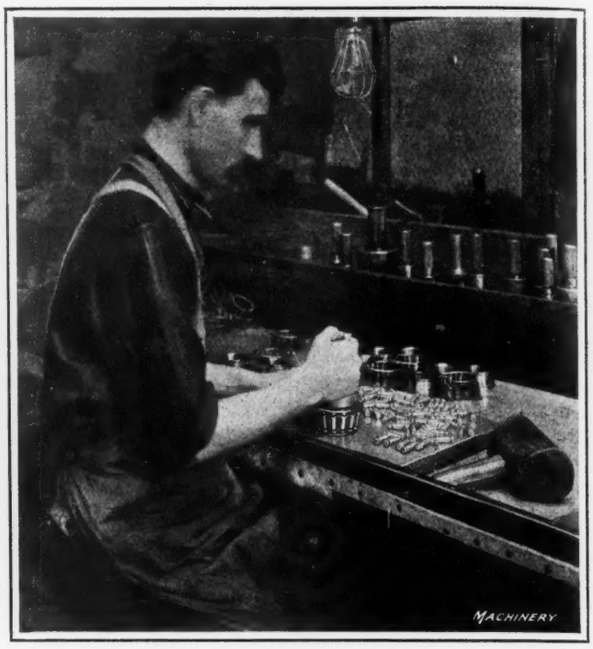



Fig. 21. Assembling Cone, Rollers, and Retainer to form a Self-contained Unit over which the Cup is placed

reaches the point where its diameter is too small to engage the contactor; then the electrical circuit at that point is broken and the trap door opened to allow the roller to pass into its proper receiver.

The machine shown in Fig. 15 is used for gaging the smaller sizes of rollers, but in the case of very large rollers the use of an automatic machine of this kind is impracticable. Consequently, special indicators are used which are operated by hand and show how much each roller is over or under the exact diameter called for by specifications. The function of this method of gaging is exactly the same, namely, to sort the work out into sixty different sizes according to the method which has already been mentioned. In addition to the necessity of gaging the rollers and sorting them into different sizes, it is of the utmost importance to have the taper on the rollers accurate, and so care must be taken to gage the rollers to ascertain that the taper angle comes within the required limits of accuracy. Automatic machines are also used for this purpose, as illustrated in Fig. 22. Here it will be seen that the rollers are fed into the machine down a chute, after which the operation is automatic.

Attention is called to the fact that there is a hemispherical member at the top of the machine, which has a finished track machined around its periphery on the under side. The rollers run between this surface and a finished surface on the top of the machine bed, and as they pass around the track each roller goes over what may be called a "rejection trap." This is nothing more than a trap door which is automatically opened in case a roller has the wrong taper angle. The method by which this mechanism operates is shown in Fig. 16, and is briefly as follows: Just before it reaches the trap door, the roller passes over a pivoted plate which is mounted on trunnions that are set parallel to the direction in which the roller runs on the track; and attached to the under side of the plate there is a metal finger

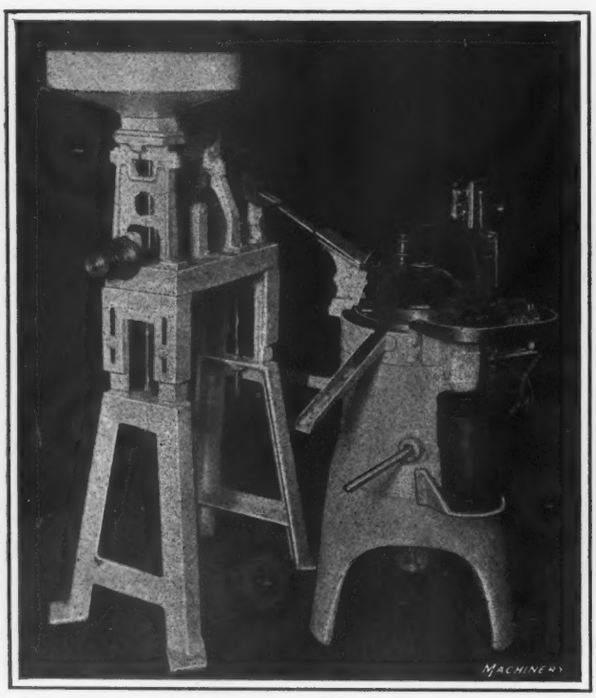



Fig. 22. Machine for gaging Taper Angle, which automatically rejects Rollers that are Defective in this Respect

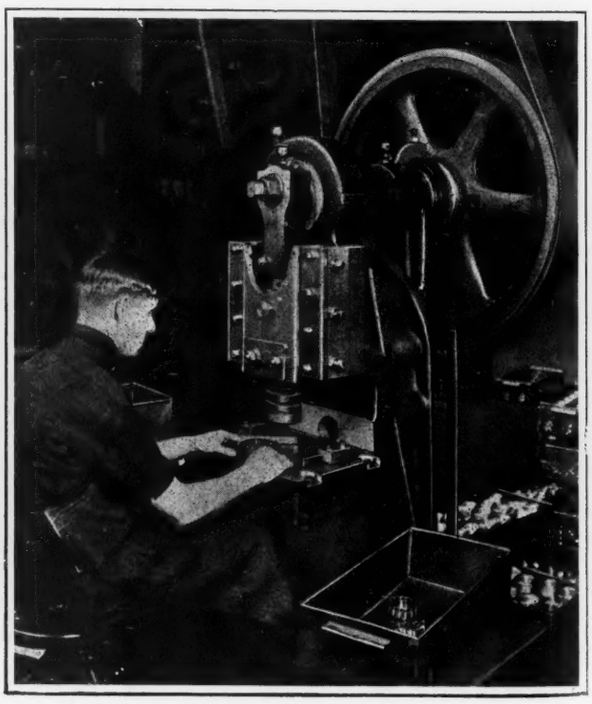


Fig. 23. Power Press equipped with Tapered Die for closing in the Retainer to make it a Close Fit on the Rollers

Fig. 24. Special Testing Machines on which Each Timken Roller Bearing is given a Trial Run to determine its Freedom from Defects in Material or Workmanship

which is swung between two electrical contacts as the plate is oscillated on its trunnion supports owing to variations of the taper angle of the successive rollers that pass over it. In event of the taper angle having an error beyond the limit of tolerance in either direction, this error in the taper angle causes the plate to swing far enough so that the finger secured to its under side comes into engagement with one of the two electrical contacts, thus causing the rejection trap to be automatically sprung by the action of an electromagnet, so that the roller drops through a chute into a receiver placed to catch it. In the case of rollers with the proper taper angle, such rollers run over the pivoted plate without causing it to swing sufficiently to cause the finger to engage either of the electrical contacts. As a result the trap-door is not opened, and the rollers pass on over it, so that they may be delivered into a container placed to receive that portion of the product which has been finished with the proper angle.

### Drawing and Piercing Roller Bearing Cages

Mention has already been made of the fact that the rollers of Timken bearings are distributed around the raceways by means of a pressed-steel cage or retainer which serves the useful purpose of holding the rollers in contact with the inner raceway or cone so that the rollers, cone, and retainer form a self-contained unit. The separator or cage is drawn up from sheet steel and has openings pierced in it to receive each of the rollers. Fig. 19 shows diagrammatically the condition of the work at each successive step in the process of manufacture, and Table 4 explains the sequence of opera-

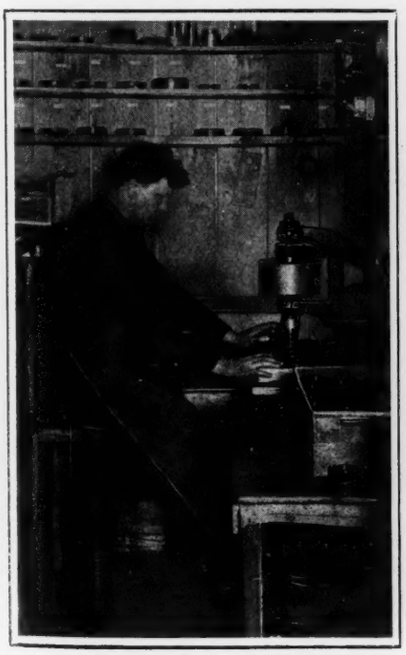


Fig. 25. Machine on which Bearings are given a "Quiet-running" Test

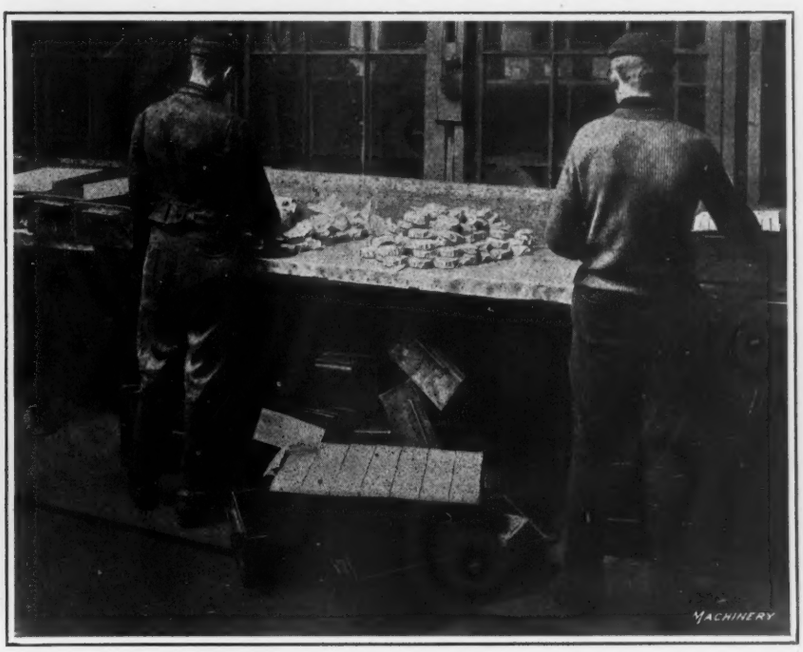


Fig. 26. Wrapping the Finished Bearings in Waxed Paper Ready to be packed in Cartons for Shipment

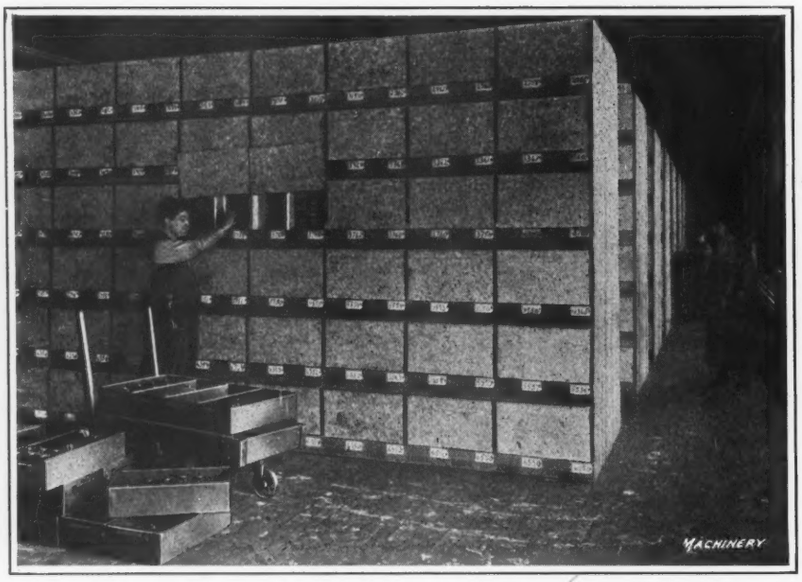


Fig. 27. Storage Bins in which Surplus Stock of Bearings is kept Ready to fill Rush Orders

tions which are involved and the types of power presses and methods of tooling which are used for the performance of each of these operations.

In Fig. 17 there is shown the No. 2 A Bliss power press which is used for the performance of piercing operations on the retainers; that is to say, the press which is employed for making the openings through which the rollers project so that they engage both the inner and outer raceways of the assembled roller bearing. This machine is equipped with a punch *A* and die *B* over which the steel cup is slipped ready to have the openings for the rollers pierced in it. Secured to the power press there is also an index mechanism which rotates the die and work carried by it to successive positions, so that repeated downward strokes of the punch result in piercing the desired holes in the work. The way in which this index mechanism operates may be briefly described as follows: Secured to the main driving shaft on the press there is a crank block *C* and connecting-rod *D*, which transmits motion through suitable links to a pawl and ratchet, so that at each stroke of the press the die and work are indexed one space.

Fig. 18 shows the power press employed for the performance of what is known as a "winging" operation on the retainers. It will be seen from the diagram Fig. 19, which illustrates the condition of the work after the performance of each operation, that the openings which are first made in the retainer to receive the rollers are of somewhat the general form of a capital letter I; that is to say, there is a head and base to the opening with a narrow portion at the center. The winging operation consists of bending back the projections of metal which separate the larger portion of the opening at either end, in order to enlarge the opening and provide inclined walls at either side. This operation is also performed under a No. 2 A Bliss power press which is shown in operation in Fig. 18. From this it will be apparent that the operation consists simply of placing the work on a die supported by a horizontal mandrel, so that a punch carried in the ram of the press can come down and bend the wings into the desired positions relative to the main body of the cage. After this operation, each piece receives a complete visual inspection as shown in Fig. 20.

### Assembling the Inner Raceway Rollers and Separator

It will be seen from Table 4, which outlines the sequence of operations which are performed on the cages of Timken roller bearings, that the final operation consists of spreading the cage sufficiently so that it can be assembled over the cone and rollers. The method of assembling consists of placing the cone or inner raceway on a bench with the small end of the taper upward, and assembling the proper number of rollers on the track around this cone. After this has been done, the cage is slipped into place over the rollers, but it is still too small to enable the cone to be easily pushed into its desired position. To accomplish this result, the work is now turned over with the large end of the cone upward, and this cone is struck a sharp blow with a heavy mallet. The result is that the cone is sprung into place and is held with the cage and rollers as a single unit. This operation of assembling is shown in Fig. 21. After it has been completed, the assembled units are taken to a power press, shown in Fig. 23, which is equipped with a suitable die to provide for closing in the cage around the rollers so that there is not an excessive amount of lost motion between the parts of the bearing.

After being pressed under the machine shown in Fig. 23, the bearings go to one of the machines shown in Fig. 24, where they are subjected to a running test under load. The idea of this test is to expose any defects in parts of the bearings, because when placed under load any serious imperfections of this nature would cause the defective part of the bearing to break, or at least make the operation so noticeably deficient that the bearing would immediately be rejected. Before going to the shipping room, all bearings are next subjected to a "quiet running" test on a machine of the type shown in Fig. 25. On this machine the bearings are driven at a speed of, roughly, 1000 revolutions per minute, and if there is any defect in the bearing this will at once become manifest by the different tone or hum that the bearing makes while in operation. After being subjected to this test, the bearings may either go directly to the ship-

Fig. 28. Gages used for testing Dimensions of Rollers produced on Automatic Screw Machines, in Order to determine the Accuracy of Tool Setting

ping room where they are wrapped in waxed paper, as shown in Fig. 26, and then placed in individual cartons which, in turn, are packed in wooden boxes; or the bearings may be placed in storage bins, Fig. 27, if there happens to be an excess supply of bearings of any given size over those that are required for immediate delivery to customers.

### Repeated Inspection of Parts During Process of Manufacture

Every engineer who has had experience with the use of anti-friction bearings knows that they are capable of operating with practically no wear, provided the bearings are properly designed, made of suitable grades of properly heat-treated steel, and providing the bearing mountings are correctly designed to exclude dirt and furnish means for the proper lubrication of the bearing members. The saving in friction that is effected through the use of roller bearings is largely due to the fact that in bearings of this type there is line contact and rolling friction between the bearing members in place of surface contact and rubbing friction in a plain bearing. The existence of line contact makes it highly important for the workmanship on roller bearing members to be absolutely perfect and for the steel to be heat-treated to give it exactly the desired physical properties, because line contact between the rollers and raceways means that the entire load on the bearing is concentrated over a very small surface. Realizing the importance of these points, the Timken Roller Bearing Co. has instituted an extremely exacting series of inspections to which all parts of their roller bearings are subjected in order to assure the rejection of all parts which fail to come up to the rigid specifications that this company requires of the product of all of its manufacturing departments. The following outline of the inspections which the different bearing parts receive will give the reader a good idea of the extreme care which is taken to assure the perfection of its product.

### Inspection of Rollers

The rollers are subjected to eight different inspections before they are finally approved and sent to the assembling department to be put into finished bearings. These various processes of inspection may be very briefly outlined as follows: (1) Samples are taken from the automatic screw machines at the start of each day's run, and gaged to make sure that the tool setting on these machines is producing work that comes within the specified limits of tolerance. (2) All rollers produced on the automatic screw machines are subjected to a careful visual inspection before going to the heat-treating department in order that those having bad tool marks, etc., may be discarded. (3) All rollers are next subjected to a careful visual inspection after being heat-treated, in order to provide for the rejection of those which have developed fire cracks or other defects. (4) After being ground, sample rollers are taken at regular intervals and carefully gaged to make sure that the setting of the grinding machine is producing work that comes within the required limits of tolerance. (5) All rollers finished in the grinding department are next given a complete visual inspection. (6) They are then sent to the automatic gaging machines on which the accuracy of the taper angle is determined, and those rollers are rejected where the error exceeds the limit of tolerance. (7) The rollers are next sent to the automatic sorting machines which grade them into sixty different sizes, to which reference has been made. (8) Finally, all rollers are given a complete visual inspection before going to the assembling department.

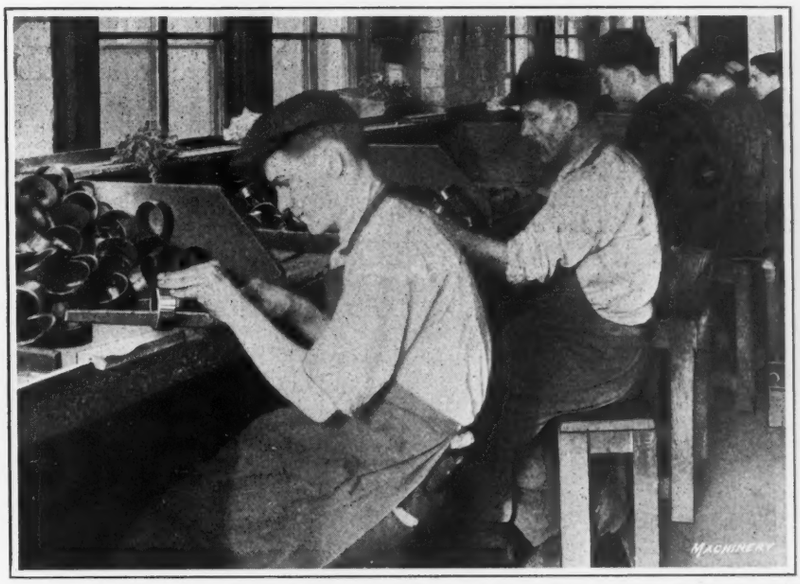



Fig. 29. After Heat-treatment, the Cups are subjected to a File Test for Hardness, a Complete Visual Inspection, and a Gage Test for Bore Diameter

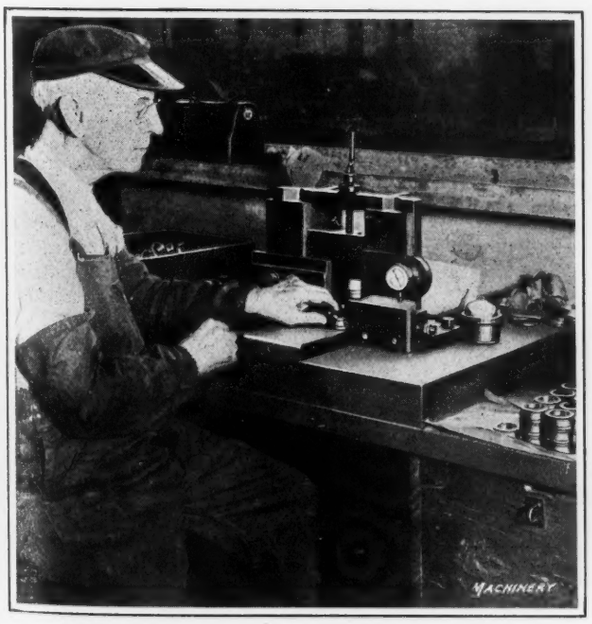



Fig. 30. Preparatory to assembling, the Cones or Inner Raceways of Timken Bearings are graded into Fifteen Different Sizes which vary from the Specified Diameter by Intervals of 0.00025 Inch, from — 0.00175 to + 0.00175 Inch

### Inspection of Cones or Inner Raceways

During the process of manufacture, the cones or inner raceways of Timken roller bearings are subjected to eight inspections in order to assure the perfection of all cones which are finally sent to the assembling department. The character of the inspections to which these parts are subjected, is briefly described in the following: (1) The first cones produced by the automatic screw machines at the beginning of each working day are sent to the chief inspector who carefully gages them to make sure that the machines are properly tooled up to produce work with dimensions which come within the specified limits of tolerance. (2) All cones produced on the automatic screw machines are gaged by the machine operators to make sure of the accuracy of contour and of the diameter of the bore. (3) The product of the automatic screw machines working on cones is next sent to the inspection room where it receives a complete inspection before being sent to the heat-treating department. (4) After being hardened, the cones are given a file test for hardness and a complete visual inspection to provide for rejecting those which have developed fire cracks or those which are imperfectly hardened; the diameter of the bore

is also gaged. (5) After performing the grinding operation in the bore of the cones, each piece is gaged by the grinding machine operator to determine the accuracy of the bore diameter, a gage of the "Go" and "Not Go" type being used for this purpose. The cones are then sent to the inspection department where they are again gaged for the accuracy of the bore diameter with "Go" and "Not Go" gages. (6) After completing each grinding operation subsequent to that performed in the bore, the work is gaged by the grinding machine operator to determine the accuracy of dimensions. (7) After grinding has been completed, the cones are sent to the inspection department where they are gaged to determine the accuracy of contour, and graded into eleven different sizes on a special machine developed for this purpose. (8) After the rollers and retainer have been assembled on the cone, each of these units is given a complete visual inspection before being sent to the testing machines. Inspectors engaged on this work turn each of the rollers in the retainer and examine the condition of the retainer and cone, so that assemblies with any apparent defects may be rejected.

Fig. 31. Special Gaging Machine used for testing the Accuracy of the Outside Diameter of Cups or Outer Raceways of Timken Roller Bearings preparatory to assembling

### Inspection of Cups or Outer Raceways

(1) An explanation has already been given of the way in which the first samples of a day's run on the automatic screw machines engaged in producing cones or inner raceways are sent to the inspection department. This practice is also followed in the case of machines engaged in the production of cups or outer raceways, in order to make sure that the tools on these machines are properly set to produce cups with dimensions that come within the specified limits of accuracy. (2) All of the cups produced on automatic screw machines are gaged by the machine operator as fast as they are finished, in order to determine the accuracy of the outside diameter and of the taper angle of the bore. Steps (3), (4), (5), and (6) in the inspection of the cups or outer raceways are exactly the same as those for the cone or inner raceway, which have already been described. (7) The final inspection given to cups or outer raceways is to set them up on a machine where the outside diameter is carefully gaged, after which the cups receive a complete visual inspection before being sent to the assembling department.

### Service Rendered by Chemical and Metallurgical Laboratories

Mechanical inspections which are conducted in manufacturing departments of the plant are supplemented by the facilities of completely equipped chemical and metallurgical laboratories, in which raw material can be thoroughly tested to determine its complete fitness for use in manufacturing the different parts of roller bearings. The advice and assistance of the chemists and metallurgists also prove invaluable in those occasional instances where trouble is experienced in producing bearing parts which thoroughly fulfill specifications. Whenever difficulty of this sort arises, it is not necessary to adopt cut-and-try methods or guesswork to find the cause and take the required steps for its correction. Scientific methods of investigation used in the laboratories enable the cause of such difficulties to be accurately determined, and with such definite information at their disposal, the engineers are able to issue specific instructions as to the method of procedure which will prove successful in correcting the difficulty.

### Conclusion

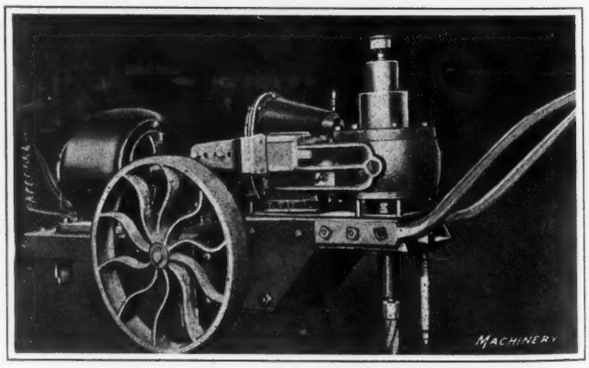
Owners of motor cars and industrial equipments of various kinds, in which Timken roller bearings are used, are familiar with the satisfactory results which they give as regards efficiency in power transmission, durability, and freedom from breakdowns. After reading this article describing the methods of manufacture, and the extreme care which is taken in inspecting the product, it will be apparent that these results are what one might naturally expect from bearings that are produced under such exacting conditions of supervision. A further safeguard against unsatisfactory service from the Timken roller bearings supplied in passenger cars, motor trucks, or equipment for industrial plants is furnished by a system whereby the Timken engineering department is required to pass upon the type and size of bearings which shall be used in each new class of installation. New orders are first sent to the engineering department, where the proper bearing to meet existing requirements is selected and a proper form of mounting is designed for the bearing. This practice avoids the trouble which would otherwise be experienced through having salesmen recommend bearings of inadequate size and of too low a carrying capacity for the requirements of the service in which they would be used.

* * *

## PORTABLE COUNTERSINKING MACHINE

BY H. L. DURLIN

The accompanying illustration shows a portable countersinking machine which was constructed by the writer for the purpose of countersinking holes in structural steel plates. The power transmission and the differential of an old automobile were utilized, as well as a five-horsepower electric motor and some odd parts of structural material. This machine is capable of countersinking 6000 holes, 13/16 inch in diameter, using a 78-degree tool, in a period of ten hours, and has proved of considerable value for the particular work for which it is intended.




Portable Countersinking Machine for Use on Structural Steel Plates

* * *

The number of women employed in the metal-working industries in Germany increased from 12,968 in 1914 to 624,688 in 1917.

# Tables for Calculating Helical Springs

BY J. H. SULLIVAN

Superintendent and Mechanical Engineer, Springfield Spring Co., Springfield, Ohio

EXISTING spring tables do not fill the requirements of the spring designer, as they are not based on stresses suitable for the commercial materials from which springs are now made; hence, the compiler of the accompanying helical spring tables found it necessary to compute entirely new tables covering the commerical sizes of helical springs. These tables are calculated for a fiber stress of 100,000 pounds per square inch, with a modulus of elasticity of 11,520,000, and apply to high-grade spring wire. Table 1 covers springs made from wire sizes varying from No. 26 (0.0181 inch) to No. 12½ (0.0985 inch) *steel wire gage* (which is the same as the American Steel & Wire Co.'s gage, the Washburn & Moen gage and the Roebling gage). Table 2 covers sizes from No. 12 (0.1055 inch) to No. 4 (0.2253 inch) steel wire gage. Table 3 covers the heavier sizes of wire from No. 3½ (0.234 inch) to ⅝ inch in diameter.

To obtain the values given in the tables, for commercial springs, the sizes covered in Tables 1 and 2 are blued at 600 degrees F., permitted to cool, and then compressed solid, after which they should return to the calculated free height. To obtain the values for springs given in Table 3, it is necessary that these larger springs be "tempered," the treatment to which they are subjected being as follows: Heat the spring to a red heat and dip it into oil, keeping it in the

TABLE 1. MAXIMUM LOADS IN POUNDS AND CORRESPONDING COMPRESSIONS PER COIL IN INCHES OF HELICAL ROUND BAR SPRINGS

| Size of Wire, Steel Wire Gage | Diam. of Wire, Inches | Mean or Pitch Diameter of Spring, Inches | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 9/32 | 5/16 | 3/8 | 7/16 | 1/2 |
| 26 | 0.0181 | 3.72<br>0.0059<br>630 | 2.48<br>0.0133<br>186 | 1.86<br>0.0236<br>79 | 1.49<br>0.037<br>40 | 1.24<br>0.053<br>23 | 1.06<br>0.072<br>15 | 0.940<br>0.094<br>10 | 0.827<br>0.119<br>7 | .....<br>.....<br>..... | ..... | ..... | ..... |
| 25 | 0.020 | 5.03<br>0.0053<br>947 | 3.35<br>0.0119<br>280 | 2.51<br>0.0213<br>118 | 2.00<br>0.0328<br>88 | 1.67<br>0.0478<br>35 | 1.43<br>0.0652<br>21 | 1.25<br>0.0852<br>14 | 1 11<br>0.107<br>10 | 1.00<br>0 131<br>7.6 | 0.837<br>0.191<br>4.3 | ..... | ..... |
| 24 | 0.023 | 7.64<br>0.0046<br>1600 | 5.10<br>0.0104<br>500 | 3.82<br>0.0184<br>200 | 3.06<br>0.0285<br>100 | 2.55<br>0.0406<br>62 | 2.19<br>0.0571<br>38 | 1.91<br>0.0714<br>25 | 1.70<br>0.0937<br>18 | 1.52<br>0.114<br>13 | 1.27<br>0.162<br>8 | ..... | ..... |
| 23 | 0.025 | 9.82<br>0.0042<br>2300 | 6.54<br>0.0095<br>680 | 4.90<br>0.0170<br>280 | 3.92<br>0.026<br>150 | 3.27<br>0.038<br>85 | 2.70<br>0.052<br>50 | 2.45<br>0.068<br>36 | 2.18<br>0.086<br>25 | 1.96<br>0.105<br>18 | 1.63<br>0.152<br>10 | 1.35<br>0.209<br>6 | ..... |
| 22 | 0.028 | .....<br>.....<br>..... | 9.19<br>0.0085<br>1070 | 6.89<br>0.0152<br>450 | 5.51<br>0.023<br>235 | 4.59<br>0.034<br>135 | 3.94<br>0.046<br>84 | 3.45<br>0.060<br>56 | 3.06<br>0.077<br>40 | 2.75<br>0.093<br>29 | 2.30<br>0.137<br>16.6 | 1.97<br>0.186<br>10.5 | ..... |
| 1/32" | 0.031 | .....<br>.....<br>..... | 12.76<br>0.0076<br>1650 | 9.57<br>0.0136<br>700 | 7.65<br>0.021<br>360 | 6.38<br>0.030<br>200 | 5.47<br>0.041<br>130 | 4.78<br>0.054<br>85 | 4 25<br>0.069<br>60 | 3.83<br>0.084<br>45 | 3.19<br>0.103<br>30 | 2.73<br>0.166<br>16 | ..... |
| 20 | 0.035 | .....<br>.....<br>..... | .....<br>.....<br>..... | 13.47<br>0.012<br>1100 | 10.77<br>0.019<br>560 | 8.98<br>0.027<br>330 | 7.69<br>0.037<br>200 | 6.73<br>0.048<br>138 | 5.98<br>0.061<br>97 | 5.38<br>0.075<br>70 | 4.49<br>0.109<br>40 | 3.84<br>0.149<br>25 | 3.36<br>0.193<br>17 |
| 19 | 0.041 | .....<br>.....<br>..... | .....<br>.....<br>..... | .....<br>.....<br>..... | ..... | 14.43<br>0.023<br>600 | 12.37<br>0.032<br>380 | 10.82<br>0.041<br>260 | 9.62<br>0.052<br>180 | 8.62<br>0.064<br>130 | 7.21<br>0.093<br>77 | 6.18<br>0.127<br>45 | 5.41<br>0.166<br>32 |

TABLE 1. MAXIMUM LOADS IN POUNDS AND CORRESPONDING COMPRESSIONS PER COIL IN INCHES OF HELICAL ROUND BAR SPRINGS—CONTINUED

| Size of Wire, Steel Wire Gage | Diam. of Wire, Inches | Mean or Pitch Diameter of Spring, Inches | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3/16 | 7/32 | 1/4 | 9/32 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 | 13/16 | 7/8 | 15/16 | 1 | 1 1/8 |
| 18 | 0.0475 | 22.44<br>0.020<br>1120 | 19.21<br>0.028<br>680 | 16.83<br>0.036<br>465 | 14.96<br>0.045<br>330 | 13.46<br>0.056<br>240 | 11.22<br>0.080<br>140 | 9 61<br>0.110<br>87 | 8.41<br>0.144<br>58 | 7.48<br>0.182<br>40 | 6.73<br>0.224<br>30 | 6 12<br>0.273<br>22 | 5.61<br>0.323<br>17 | ....<br>....<br>.... | ....<br>....<br>.... | ....<br>....<br>.... | ....<br>....<br>.... | ....<br>....<br>.... |
| 17 | 0.054 | .....<br>.....<br>..... | 28.26<br>0.024<br>1180 | 24.73<br>0.031<br>800 | 21.98<br>0.040<br>500 | 19.80<br>0 049<br>400 | 16.50<br>0.071<br>230 | 14.13<br>0.096<br>145 | 12.36<br>0.126<br>95 | 10.99<br>0.158<br>68 | 9.90<br>0.194<br>50 | 9.00<br>0.238<br>38 | 8.25<br>0.284<br>29 | ....<br>....<br>.... | ....<br>....<br>.... | ....<br>....<br>.... | ....<br>....<br>.... | ....<br>....<br>.... |
| 16 | 0.0625 | .....<br>.....<br>..... | .....<br>.....<br>..... | 38.35<br>0.027<br>1400 | 34.09<br>0.034<br>1000 | 30.67<br>0.042<br>720 | 25.56<br>0.061<br>410 | 21.91<br>0.083<br>260 | 19.17<br>0.108<br>170 | 17.04<br>0.138<br>120 | 15.34<br>0.168<br>90 | 13.91<br>0.206<br>65 | 12.78<br>0.245<br>52 | 11.80<br>0.288<br>40 | 10.95<br>0.334<br>30 | 10.22<br>0.383<br>25 | 9.58<br>0.435<br>21 | 8.52<br>0.552<br>15 |
| 15 | 0.072 | .....<br>.....<br>..... | .....<br>.....<br>..... | 58.23<br>0 0236<br>2460 | 51.72<br>0 031<br>1630 | 46.58<br>0.037<br>1250 | 38.80<br>0.053<br>730 | 33 27<br>0.069<br>480 | 29.11<br>0.095<br>300 | 25.86<br>0.119<br>215 | 23.29<br>0.148<br>155 | 21.17<br>0.178<br>118 | 19.40<br>0.213<br>90 | 18.05<br>0.250<br>77 | 16.63<br>0.276<br>60 | 15.63<br>0.333<br>47 | 14.55<br>0.378<br>38 | 12.93<br>0.479<br>26 |
| 14 | 0.080 | .....<br>.....<br>..... | .....<br>.....<br>..... | 80.42<br>0.0213<br>3700 | 71.48<br>0.027<br>2640 | 64.34<br>0.033<br>1940 | 53.6<br>0.048<br>1110 | 46.0<br>0.065<br>700 | 40.2<br>0.085<br>470 | 35.7<br>0.107<br>330 | 32.17<br>0.133<br>240 | 29.2<br>0 162<br>180 | 26.8<br>0.191<br>140 | 24.7<br>0.225<br>110 | 23.0<br>0.261<br>88 | 21.4<br>0.300<br>70 | 20.1<br>0:341<br>59 | 17.8<br>0.431<br>40 |
| 13½ | 0.08575 | .....<br>.....<br>..... | .....<br>.....<br>..... | 99<br>0.020<br>4950 | 88<br>0.025<br>3500 | 79<br>0.031<br>2550 | 66<br>0.046<br>1440 | 56.5<br>0.061<br>926 | 49.5<br>0.079<br>623 | 44.0<br>0.100<br>440 | 39.6<br>0.124<br>319 | 36.0<br>0.150<br>240 | 33.0<br>0.179<br>185 | 30.4<br>0.210<br>145 | 28.3<br>0.244<br>116 | 26.4<br>0.281<br>94 | 24.7<br>0.318<br>78 | 22.0<br>0.402<br>55 |
| 13 | 0.091 | .....<br>.....<br>..... | .....<br>.....<br>..... | 120<br>0.0185<br>6400 | 107<br>0.023<br>4600 | 92<br>0.029<br>3300 | 80<br>0.042<br>1900 | 69<br>0.057<br>1200 | 60<br>0.074<br>800 | 53.4<br>0.094<br>560 | 48.1<br>0.116<br>400 | 43.7<br>0.141<br>300 | 40.1<br>0.167<br>240 | 37.0<br>0.197<br>185 | 34.3<br>0.228<br>150 | 32.0<br>0.263<br>120 | 30.0<br>0.297<br>100 | 26 7<br>0.377<br>70 |
| 12½ | 0.0985 | .....<br>.....<br>..... | .....<br>.....<br>..... | 150<br>0.017<br>8600 | 133<br>0.022<br>6000 | 120<br>0.027<br>4400 | 100<br>0.039<br>2550 | 85.8<br>0.053<br>1600 | 75.0<br>0.069<br>1080 | 66.7<br>0.087<br>760 | 60.0<br>0.108<br>555 | 54.6<br>0.131<br>400 | 50.0<br>0.155<br>320 | 46.0<br>0.182<br>250 | 42.9<br>0 212<br>200 | 40.0<br>0.243<br>164 | 37.5<br>0.276<br>135 | 33.3<br>0.350<br>95 |

oil until it is quite cool; then burn off or flash off the oil, which has the same effect as drawing the temper. An exception is made in the case of car springs, which are dipped into oil and taken out again while they still show red or dark red. These springs are not flashed off.

Wire springs (as specified in Tables 1 and 2) are allowed to remain some time in the oil (usually the time required for heating another lot of springs, which would be about seven minutes). They are then thrown on the floor and the temper is drawn during the last hours of the day when the hardening will also show whether the spring is defective. If the spring is a compression spring and it is compressed solid, the coils, when released, should have a movement per coil as specified in the table. If they do not have this movement, the spring has not been hardened sufficiently. Should the spring give more space between the coils than specified in the tables in the line for "movement per coil," then the spring is too highly hardened and will not last long. The temper can then be drawn until the proper degree of hardness is obtained. The basis of 100,000 pounds per square

TABLE 2. MAXIMUM LOADS IN POUNDS AND CORRESPONDING COMPRESSIONS PER COIL IN INCHES OF HELICAL ROUND BAR SPRINGS

| Size of Wire, Steel Wire Gage | Diam. of Wire, Inches | Mean or Pitch Diameter of Spring, Inches | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 3/8 | 1 1/2 | 1 5/8 | 1 3/4 | 1 7/8 | 2 | 2 1/8 | 2 1/4 | 2 3/8 | 2 1/2 |
| 12 | 0.1055 | 145 | 121 | 104 | 91 | 81 | 73 | 66 | 61 | 52 | 45 | 40 | 36 | 33 | 30 | 28 | 26 | 24 | 22.7 | ... | ... | ... | ... |
| | | 0.025 | 0.036 | 0.049 | 0.065 | 0.082 | 0.101 | 0.122 | 0.146 | 0.198 | 0.260 | 0.328 | 0.406 | 0.488 | 0.584 | 0.686 | 0.795 | 0.913 | 1.038 | ... | ... | ... | ... |
| | | 5770 | 3300 | 2050 | 1400 | 980 | 720 | 540 | 410 | 260 | 170 | 120 | 89 | 67 | 50 | 40 | 32 | 26 | 20 | ... | ... | ... | ... |
| 11½ | 0.113 | 181 | 151 | 129 | 113 | 100 | 91 | 82 | 75 | 64.7 | 56.6 | 50.3 | 45.3 | 41.1 | 37.8 | 34.8 | 32.3 | 30.1 | 28.3 | ... | ... | ... | ... |
| | | 0.023 | 0.034 | 0.046 | 0.060 | 0.076 | 0.094 | 0.113 | 0.136 | 0.185 | 0.241 | 0.305 | 0.377 | 0.454 | 0.543 | 0.637 | 0.739 | 0.848 | 0.964 | ... | ... | ... | ... |
| | | 7700 | 4400 | 2800 | 1850 | 1300 | 960 | 780 | 550 | 340 | 234 | 165 | 120 | 90 | 69 | 54 | 43 | 35 | 29 | ... | ... | ... | ... |
| 11 | 0.120 | ... | 180 | 155 | 136 | 121 | 108 | 99 | 90.4 | 77.5 | 67.8 | 60.3 | 54.2 | 49.3 | 45.2 | 41.7 | 38.7 | 36.2 | 33.9 | 31.9 | 30.1 | ... | ... |
| | | ... | 0.032 | 0.043 | 0.057 | 0.072 | 0.089 | 0.106 | 0.128 | 0.174 | 0.227 | 0.287 | 0.355 | 0.427 | 0.511 | 0.600 | 0.696 | 0.800 | 0.909 | 1.026 | 1.150 | ... | .. |
| | | ... | 5600 | 3600 | 2380 | 1670 | 1200 | 930 | 700 | 445 | 300 | 260 | 150 | 115 | 88 | 70 | 55 | 45 | 37 | 31 | 27 | ... | ... |
| 10½ | 0.127 | ... | 284 | 183 | 161 | 143 | 128 | 117 | 107 | 92 | 80 | 71.5 | 64 | 58.5 | 53.6 | 49 | 46 | 42.9 | 40 | 38 | 36 | ... | ... |
| | | ... | 0.029 | 0.041 | 0 053 | 0.068 | 0.084 | 0.101 | 0.121 | 0.164 | 0.214 | 0.271 | 0.335 | 0.404 | 0.483 | 0.567 | 0.657 | 0.755 | 0.858 | 0.970 | 1.084 | ... | ... |
| | | ... | 7300 | 4400 | 3000 | 2000 | 1500 | 1100 | 880 | 550 | 370 | 260 | 190 | 140 | 110 | 85 | 70 | 56 | 46 | 39 | 33 | ... | ... |
| 10 | 0.135 | ... | ... | 220 | 193 | 172 | 155 | 140 | 129 | 110 | 96 | 86 | 77 | 70 | 64 | 59.4 | 55 | 51.5 | 48 | 45.4 | 43 | ... | ... |
| | | ... | ... | 0.039 | 0.050 | 0.064 | 0.079 | 0.095 | 0.113 | 0.154 | 0.202 | 0.255 | 0.315 | 0.380 | 0.454 | 0.533 | 0.618 | 0.710 | 0.808 | 0.912 | 1.020 | ... | ... |
| | | ... | ... | 5500 | 3800 | 2680 | 1960 | 1460 | 1140 | 700 | 470 | 330 | 240 | 180 | 140 | 110 | 88 | 72 | 59 | 49 | 42 | ... | ... |
| 9½ | 0.141 | ... | ... | 252 | 220 | 196 | 176 | 160 | 147 | 126 | 110 | 98 | 89 | 80 | 73 | 68 | 63 | 59 | 55 | 51.8 | 49 | ... | ... |
| | | ... | ... | 0.037 | 0.048 | 0.061 | 0.075 | 0.091 | 0.109 | 0.148 | 0.193 | 0.244 | 0.302 | 0.364 | 0.435 | 0.510 | 0.594 | 0.680 | 0.772 | 0.873 | 0.978 | ... | ... |
| | | ... | ... | 6700 | 4500 | 3100 | 2300 | 1700 | 1300 | 840 | 550 | 400 | 290 | 200 | 165 | 130 | 105 | 85 | 70 | 59 | 50 | ... | ... |
| 9 | 0.148 | ... | ... | ... | 254 | 224 | 203 | 185 | 170 | 146 | 127 | 112 | 102 | 93 | 85 | 78.3 | 73 | 68 | 63.6 | 60 | 56 | 53.7 | 52 |
| | | ... | ... | ... | 0 046 | 0.058 | 0.072 | 0.087 | 0.103 | 0.141 | 0.184 | 0.233 | 0.287 | 0.350 | 0.412 | 0.486 | 0.564 | 0.648 | 0.736 | 0.832 | 0.932 | 1.039 | 1.150 |
| | | ... | ... | ... | 5500 | 3860 | 2800 | 2100 | 1650 | 1000 | 690 | 480 | 355 | 265 | 206 | 160 | 129 | 104 | 86 | 72 | 60 | 51 | 45 |
| 8½ | 0.1562 | ... | ... | ... | 299 | 266 | 239 | 218 | 199 | 171 | 149 | 133 | 120 | 109 | 100 | 92 | 85.5 | 79.5 | 74.5 | 70.5 | 66.5 | 63 | 60 |
| | | ... | ... | ... | 0 043 | 0.055 | 0.068 | 0.082 | 0.098 | 0.134 | 0.174 | 0.220 | 0.272 | 0.330 | 0.392 | 0.460 | 0.534 | 0.611 | 0.696 | 0.788 | 0.883 | 0.976 | 1.088 |
| | | ... | ... | ... | 7000 | 4800 | 3500 | 2650 | 2000 | 1270 | 855 | 600 | 440 | 330 | 260 | 200 | 160 | 130 | 107 | 90 | 75 | 64 | 55 |

TABLE 2. MAXIMUM LOADS IN POUNDS AND CORRESPONDING COMPRESSIONS PER COIL IN INCHES OF HELICAL ROUND BAR SPRINGS—CONTINUED

| Size of Wire, Steel Wire Gage | Diam. of Wire, Inches | Mean or Pitch Diameter of Spring, Inches | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 9/16 | 5/8 | 11/16 | 3/4 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 3/8 | 1 1/2 | 1 5/8 | 1 3/4 | 1 7/8 | 2 | 2 1/8 | 2 1/4 | 2 3/8 | 2 1/2 | 2 5/8 | | | |
| 8 | 0.162 | 296 | 267 | 243 | 223 | 191 | 167 | 148 | 133 | 121 | 111 | 102 | 95 | 89 | 83 | 78.5 | 74 | 70 3 | 66 7 | 63 6 | | | |
| | | 0 053 | 0.066 | 0.080 | 0.095 | 0.129 | 0 162 | 0.213 | 0.263 | 0.320 | 0.378 | 0.444 | 0.515 | 0.591 | 0.673 | 0.760 | 0 851 | 0.949 | 1 052 | 1.165 | | | |
| | | 5380 | 4000 | 3000 | 2300 | 1480 | 1000 | 700 | 500 | 380 | 295 | 230 | 184 | 150 | 123 | 103 | 86 | 74 | 63 | 54 | | | |
| 7½ | 0.170 | 343 | 309 | 280 | 257 | 220 | 193 | 171 | 154 | 140 | 128 | 119 | 110 | 103 | 96 | 91 | 85.7 | 81 | 77 | 73.5 | | | |
| | | 0.051 | 0.063 | 0.076 | 0.090 | 0 123 | 0.160 | 0 203 | 0.261 | 0 302 | 0.361 | 0.423 | 0.491 | 0.563 | 0.641 | 0 724 | 0 812 | 0.905 | 1 043 | 1.108 | | | |
| | | 6700 | 4900 | 3680 | 2800 | 1780 | 1200 | 840 | 590 | 460 | 350 | 280 | 240 | 180 | 148 | 125 | 105 | 90 | 74 | 65 | | | |
| 7 | 0.177 | 387 | 348 | 316 | 290 | 249 | 217 | 193 | 174 | 158 | 145 | 134 | 124 | 116 | 109 | 102 | 97 | 92 | 87 | 83 | | | |
| | | 0.049 | 0.060 | 0.073 | 0.087 | 0.118 | 0.154 | 0.195 | 0.240 | 0.289 | 0.346 | 0.407 | 0.472 | 0.541 | 0.616 | 0.696 | 0 780 | 0.870 | 0.962 | 1.064 | | | |
| | | 7900 | 5800 | 4300 | 3300 | 2100 | 1400 | 1000 | 725 | 540 | 418 | 329 | 262 | 214 | 175 | 146 | 124 | 105 | 90 | 78 | | | |
| 3/16" | 0.1875 | .... | 414 | 376 | 345 | 296 | 259 | 230 | 207 | 188 | 172 | 159 | 148 | 139 | 129 | 122 | 115 | 109 | 103 | 98.6 | | | |
| | | .... | 0.057 | 0.069 | 0.081 | 0.111 | 0.145 | 0.184 | 0.227 | 0.276 | 0.327 | 0.384 | 0.445 | 0.511 | 0.582 | 0.657 | 0.736 | 0.800 | 0.908 | 1.004 | | | |
| | | .... | 7250 | 5440 | 4250 | 2650 | 1730 | 1250 | 900 | 680 | 520 | 410 | 330 | 270 | 220 | 170 | 156 | 135 | 110 | 98 | | | |
| 6 | 0.192 | .... | 445 | 404 | 370 | 317 | 278 | 247 | 222 | 202 | 184 | 171 | 159 | 148 | 139 | 131 | 123 | 117 | 111 | 106 | | | |
| | | .... | 0 055 | 0.067 | 0.080 | 0.108 | 0.142 | 0.180 | 0.222 | 0.267 | 0 320 | 0.375 | 0.435 | 0.499 | 0 568 | 0.641 | 0.720 | 0.801 | 0.887 | 0.981 | | | |
| | | .... | 8000 | 6000 | 4600 | 2900 | 1900 | 1370 | 1000 | 750 | 570 | 450 | 365 | 296 | 244 | 200 | 170 | 145 | 125 | 108 | | | |
| 5 | 0.207 | .... | .... | 506 | 464 | 398 | 348 | 309 | 278 | 253 | 232 | 214 | 199 | 186 | 174 | 164 | 154 | 147 | 139 | 132 | | | |
| | | .... | .... | 0.062 | 0.074 | 0.100 | 0.131 | 0.166 | 0.206 | 0.248 | 0.296 | 0.347 | 0.403 | 0 462 | 0.526 | 0.595 | 0.666 | 0 743 | 0.824 | 0.910 | | | |
| | | .... | .... | 8000 | 6200 | 3900 | 2600 | 1850 | 1350 | 1000 | 780 | 610 | 490 | 400 | 330 | 275 | 230 | 200 | 168 | 145 | | | |
| 7/32" | 0.21875 | .... | .... | .... | 553 | 473 | 414 | 368 | 331 | 301 | 276 | 255 | 237 | 221 | 207 | 195 | 184 | 174 | 165 | 158 | | | |
| | | ... | .... | .... | 0.070 | 0.095 | 0.125 | 0.158 | 0.195 | 0.234 | 0.280 | 0.329 | 0.381 | 0.438 | 0.498 | 0.563 | 0.631 | 0.703 | 0.779 | 0.861 | | | |
| | | .... | .... | .... | 7900 | 4960 | 3330 | 2325 | 1700 | 1280 | 985 | 775 | 620 | 500 | 415 | 345 | 290 | 245 | 210 | 183 | | | |
| 4 | 0.2253 | .... | .... | .... | 596 | 512 | 447 | 397 | 357 | 325 | 298 | 275 | 256 | 238 | 223 | 210 | 199 | 188 | 178 | 170 | | | |
| | | . . | .... | ... | 0.068 | 0.093 | 0 121 | 0.153 | 0.189 | 0.228 | 0.272 | 0.320 | 0.371 | 0.426 | 0.484 | 0.547 | 0.613 | 0.683 | 0.757 | 0.837 | | | |
| | | .... | . . | .... | 8700 | 5500 | 3690 | 2580 | 1850 | 1400 | 1090 | 850 | 660 | 550 | 460 | 380 | 324 | 275 | 235 | 200 | | | |

heat of the furnace is going down, or during the first hour in the morning when the heat of the furnace is coming up.

The reason why springs made from the larger sizes of wire require different treatment is that the wire itself has not had the same amount of work put upon it in its manufacture as the smaller sizes, and hence does not have inherent in it the same high tensile strength as the smaller sizes; but a fiber stress of 100,000 pounds per square inch is permissible for a spring treated by the hardening processes specified above, after the spring is coiled. This process of inch stress, which has been used for calculating the tables, is an ample figure to use for the sizes given in Tables 1 and 2, but may be considered the limiting value for Table 3.

### Values Given in the Tables

The tables give in the extreme left-hand column, the size of the wire from which the spring is made, both by gage number (steel wire gage) and in decimals. Along the top of the tables is given the mean or pitch diameter of the spring. To find the values relating to any one spring,

therefore, first locate in the left-hand column the size of wire from which the spring is made, and then follow the horizontal line from this size to the column headed by the mean diameter of the spring. For example, assume that the values for a spring made from No. 10 gage wire, having a mean or pitch diameter of 1⅛ inch, are to be found. In Table 2 the No. 10 wire is located in the left-hand column, and then the lines applying to this size of wire are followed horizontally until the column headed 1⅛ is reached. Here we find three values given one above the other as follows: 86, 0.255, and 330. The top value gives the load in pounds required to compress the spring solid, or the total capacity of the spring. In this case, 86 pounds would be required to compress the spring solid. The second value, 0.255, gives the movement per coil in inches when the spring is compressed from its free height to solid, this value also often being known as the "deflection under total load, per coil." In this case then, the deflection, under a load of 86 pounds, is 0.255 inch per coil. The third value, 330, is a constant; if this constant is divided by the number of working coils in the entire spring, the load in pounds required to compress the spring one inch will be found. This constant is not given in any spring tables that have been compiled in the past.

### Using Spring Tables for Stresses other than 100,000 Pounds per Square Inch

In order to apply the spring tables to stresses other than 100,000 pounds per square inch, it is necessary only to take a percentage of the load, as shown in the tables, corresponding to the percentage that the stress required is of 100,000 pounds; in other words, if we wish to design springs in which the fiber stress is only 60,000 pounds per square inch, the loads and the movements per coil (or deflections) given in the table should be taken at 60 per cent of the values found from the table. For gas engine springs, where the compressions run from 175 to 250 per minute, a fiber stress of 60,000 pounds per square inch is as high as it is safe to assume. In that case, 60 per cent of the figures shown in the table for the load and the movement per coil should be used. The third value given for each size of wire, that is, the

TABLE 3. MAXIMUM LOADS IN POUNDS AND CORRESPONDING COMPRESSIONS PER COIL IN INCHES OF HELICAL ROUND BAR SPRINGS

| Size of Wire, Steel Wire Gage | Diam. of Wire, Inches | Mean or Pitch Diameter of Spring, Inches | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 1⅛ | 1¼ | 1⅜ | 1½ | 1⅝ | 1¾ | 1⅞ | 2 | 2⅛ | 2¼ | 2⅜ | 2½ | 2⅝ | 2¾ | 2⅞ | 3 | 3¼ | 3½ | 3¾ | 4 | 4½ |
| 3½ | 0.234 | 503 | 447 | 402 | 366 | 335 | 310 | 287 | 269 | 251 | 237 | 223 | 212 | 201 | 191 | 183 | 175 | 168 | 155 | 144 | 134 | 126 | ... |
| | | 0.117 | 0.147 | 0.182 | 0.220 | 0.262 | 0.308 | 0.357 | 0.410 | 0.467 | 0.526 | 0.590 | 0.657 | 0.728 | 0.805 | 0.881 | 0.963 | 1.048 | 1.232 | 1.428 | 1.640 | 1.869 | ... |
| | | 4260 | 3000 | 2200 | 1650 | 1270 | 1000 | 800 | 650 | 530 | 440 | 375 | 320 | 275 | 235 | 207 | 180 | 160 | 125 | 100 | 80 | 67 | ... |
| 3 | 0.244 | 570 | 507 | 456 | 414 | 380 | 351 | 326 | 304 | 285 | 268 | 253 | 240 | 228 | 217 | 207 | 199 | 190 | 175 | 163 | 152 | 142 | ... |
| | | 0.112 | 0.141 | 0.175 | 0.210 | 0.250 | 0.295 | 0.342 | 0.392 | 0.447 | 0.504 | 0.565 | 0.630 | 0.698 | 0.771 | 0.840 | 0.923 | 1.000 | 1.180 | 1.368 | 1.568 | 1.788 | ... |
| | | 3080 | 3590 | 2600 | 1970 | 1500 | 1185 | 950 | 775 | 637 | 530 | 447 | 380 | 326 | 280 | 246 | 215 | 190 | 148 | 119 | 97 | 79 | ... |
| ¼" | 0.250 | 614 | 545 | 491 | 446 | 409 | 378 | 351 | 327 | 307 | 289 | 273 | 258 | 245 | 233 | 223 | 213 | 204 | 189 | 175 | 164 | 153 | ... |
| | | 0.109 | 0.138 | 0.170 | 0.205 | 0.245 | 0.288 | 0.334 | 0.383 | 0.436 | 0.492 | 0.552 | 0.615 | 0.680 | 0.753 | 0.820 | 0.901 | 0.983 | 1.152 | 1.336 | 1.533 | 1.744 | ... |
| | | 5625 | 3940 | 2880 | 2170 | 1665 | 1310 | 1050 | 850 | 700 | 587 | 494 | 419 | 360 | 310 | 270 | 236 | 205 | 164 | 130 | 106 | 87 | ... |
| 2 | 0.263 | 714 | 635 | 571 | 519 | 476 | 440 | 408 | 381 | 357 | 336 | 317 | 301 | 285 | 272 | 259 | 249 | 238 | 220 | 204 | 190 | 178 | ... |
| | | 0.103 | 0.131 | 0.162 | 0.195 | 0.233 | 0.273 | 0.317 | 0.364 | 0.414 | 0.468 | 0.524 | 0.585 | 0.648 | 0.716 | 0.780 | 0.857 | 0.933 | 1.095 | 1.270 | 1.468 | 1.656 | ... |
| | | 7000 | 4820 | 3520 | 2660 | 2000 | 1600 | 1280 | 1045 | 860 | 720 | 600 | 510 | 440 | 380 | 330 | 290 | 255 | 193 | 160 | 128 | 107 | ... |
| 1 | 0.283 | ... | 788 | 710 | 646 | 592 | 546 | 507 | 474 | 444 | 418 | 398 | 374 | 355 | 338 | 323 | 309 | 296 | 273 | 254 | 237 | 222 | ... |
| | | ... | 0.122 | 0.150 | 0.181 | 0.217 | 0.254 | 0.295 | 0.339 | 0.386 | 0.435 | 0.487 | 0.543 | 0.602 | 0.665 | 0.724 | 0.797 | 0.868 | 1.017 | 1.180 | 1.355 | 1.545 | ... |
| | | ... | 6450 | 4750 | 3565 | 2725 | 2140 | 1718 | 1400 | 1150 | 960 | 817 | 688 | 590 | 508 | 446 | 387 | 341 | 268 | 215 | 175 | 143 | ... |
| 0 | 0.307 | ... | 1005 | 909 | 326 | 757 | 699 | 649 | 606 | 568 | 535 | 505 | 478 | 454 | 433 | 413 | 395 | 378 | 350 | 324 | 303 | 284 | ... |
| | | ... | 0.112 | 0.139 | 0.168 | 0.200 | 0.234 | 0.272 | 0.312 | 0.355 | 0.401 | 0.450 | 0.501 | 0.555 | 0.613 | 0.671 | 0.734 | 0.800 | 0.938 | 1.090 | 1.249 | 1.421 | ... |
| | | ... | 9000 | 6500 | 4900 | 3780 | 2990 | 2380 | 1940 | 1600 | 1300 | 1120 | 950 | 810 | 700 | 615 | 540 | 470 | 370 | 300 | 240 | 200 | ... |
| 5/16" | 0.3125 | ... | 1073 | 966 | 880 | 805 | 743 | 690 | 644 | 604 | 568 | 537 | 509 | 483 | 460 | 439 | 420 | 403 | 371 | 345 | 322 | 302 | 268 |
| | | ... | 0.110 | 0.136 | 0.165 | 0.196 | 0.230 | 0.267 | 0.307 | 0.349 | 0.394 | 0.441 | 0.492 | 0.545 | 0.608 | 0.660 | 0.721 | 0.785 | 0.922 | 1.069 | 1.227 | 1.396 | 1.764 |
| | | ... | 9700 | 7000 | 5300 | 4100 | 3200 | 2580 | 2100 | 1860 | 1440 | 1210 | 1000 | 885 | 780 | 665 | 580 | 510 | 400 | 320 | 260 | 215 | 151 |
| 00 | 0.331 | ... | 1266 | 1146 | 1035 | 949 | 876 | 814 | 765 | 712 | 670 | 633 | 600 | 570 | 542 | 518 | 495 | 474 | 438 | 407 | 382 | 356 | 317 |
| | | ... | 0.104 | 0.129 | 0.156 | 0.185 | 0.218 | 0.252 | 0.289 | 0.329 | 0.372 | 0.416 | 0.465 | 0.515 | 0.569 | 0.623 | 0.681 | 0.741 | 0.870 | 1.009 | 1.158 | 1.316 | 1.664 |
| | | ... | 12,170 | 8880 | 6630 | 5130 | 4010 | 3230 | 2645 | 2165 | 1800 | 1520 | 1290 | 1100 | 952 | 830 | 726 | 638 | 500 | 403 | 329 | 270 | 190 |
| 11/32" | 0.34375 | ... | ..... | 1276 | 1160 | 1063 | 981 | 911 | 851 | 797 | 751 | 709 | 672 | 638 | 608 | 580 | 555 | 531 | 491 | 456 | 425 | 399 | 354 |
| | | ... | ..... | 0.124 | 0.149 | 0.178 | 0.209 | 0.243 | 0.279 | 0.314 | 0.358 | 0.401 | 0.447 | 0.495 | 0.548 | 0.597 | 0.656 | 0.712 | 0.837 | 0.971 | 1.116 | 1.259 | 1.604 |
| | | ... | ..... | 10,200 | 7785 | 6970 | 4690 | 3750 | 3048 | 2530 | 2097 | 1768 | 1500 | 1290 | 1100 | 970 | 846 | 760 | 586 | 469 | 380 | 317 | 220 |
| 000 | 0.362 | ... | ..... | 1490 | 1355 | 1242 | 1146 | 1064 | 993 | 931 | 876 | 828 | 788 | 745 | 709 | 677 | 648 | 621 | 573 | 532 | 497 | 465 | 414 |
| | | ... | ..... | 0.116 | 0.140 | 0.168 | 0.196 | 0.231 | 0.265 | 0.301 | 0.337 | 0.377 | 0.421 | 0.467 | 0.520 | 0.562 | 0.620 | 0.678 | 0.784 | 0.923 | 1.059 | 1.204 | 1.508 |
| | | ... | ..... | 12,860 | 0670 | 7300 | 5845 | 4600 | 3745 | 3100 | 2600 | 2195 | 1870 | 1638 | 1363 | 1200 | 1040 | 916 | 730 | 576 | 468 | 385 | 274 |

TABLE 3. MAXIMUM LOADS IN POUNDS AND CORRESPONDING COMPRESSIONS PER COIL IN INCHES OF HELICAL ROUND BAR SPRINGS—CONTINUED

| Size of Wire, Steel Wire Gage | Diam. of Wire, Inches | Mean or Pitch Diameter of Spring, Inches | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1⅜ | 1½ | 1⅝ | 1¾ | 1⅞ | 2 | 2⅛ | 2¼ | 2⅜ | 2½ | 2⅝ | 2¾ | 2⅞ | 3 | 3¼ | 3½ | 3¾ | 4 | 4½ | 5 | 5½ |
| 3/8" | 0.375 | 1506 | 1380 | 1274 | 1183 | 1104 | 1035 | 974 | 920 | 872 | 828 | 789 | 753 | 720 | 690 | 637 | 591 | 553 | 518 | 460 | ... | ... |
| | | 0.137 | 0.164 | 0.192 | 0.227 | 0.256 | 0.291 | 0.328 | 0.368 | 0.410 | 0.455 | 0.504 | 0.550 | 0.601 | 0.654 | 0.768 | 0.891 | 1.022 | 1.164 | 1.572 | ... | ... |
| | | 11,000 | 8400 | 6600 | 5200 | 4300 | 3550 | 2960 | 2500 | 2120 | 1810 | 1565 | 1365 | 1200 | 1050 | 829 | 660 | 540 | 445 | 225 | ... | ... |
| 13/32" | 0.406 | 1911 | 1752 | 1617 | 1500 | 1402 | 1314 | 1237 | 1168 | 1106 | 1051 | 1000 | 955 | 911 | 876 | 808 | 750 | 701 | 657 | 584 | 526 | ... |
| | | 0.126 | 0.151 | 0.177 | 0.205 | 0.236 | 0.268 | 0.306 | 0.340 | 0.380 | 0.420 | 0.465 | 0.508 | 0.555 | 0.604 | 0.709 | 0.822 | 0.944 | 1.074 | 1.360 | 1.679 | ... |
| | | 15,160 | 11,600 | 9130 | 7300 | 5900 | 4900 | 4040 | 3430 | 2900 | 2600 | 2150 | 1870 | 1640 | 1450 | 1130 | 912 | 740 | 610 | 425 | 313 | .... |
| 7/16" | 0.4375 | 2384 | 2192 | 2022 | 1979 | 1754 | 1644 | 1547 | 1460 | 1384 | 1315 | 1252 | 1192 | 1144 | 1096 | 1011 | 939 | 877 | 822 | 730 | 657 | ... |
| | | 0.118 | 0.140 | 0.165 | 0.191 | 0.219 | 0.249 | 0.281 | 0.315 | 0.351 | 0.389 | 0.430 | 0.471 | 0.515 | 0.560 | 0.658 | 0.763 | 0.876 | 0.995 | 1.262 | 1.558 | ... |
| | | 20,100 | 15,650 | 12,250 | 10,360 | 8000 | 6600 | 5500 | 4630 | 3940 | 3380 | 2925 | 2530 | 2220 | 1950 | 1535 | 1230 | 1000 | 825 | 578 | 420 | ... |
| 15/32" | 0.46875 | ... | 2696 | 2489 | 2311 | 2157 | 2022 | 1903 | 1797 | 1703 | 1617 | 1541 | 1470 | 1407 | 1348 | 1244 | 1155 | 1078 | 1011 | 898 | 809 | ... |
| | | ... | 0.130 | 0.153 | 0.178 | 0.204 | 0.232 | 0.263 | 0.295 | 0.328 | 0.363 | 0.401 | 0.440 | 0.480 | 0.523 | 0.614 | 0.713 | 0.818 | 0.931 | 1.180 | 1.454 | ... |
| | | ... | 20,500 | 16,200 | 13,000 | 10,500 | 8715 | 7235 | 6090 | 5190 | 4450 | 3850 | 3340 | 2930 | 2570 | 2020 | 1620 | 1315 | 1075 | 830 | 555 | ... |
| ½" | 0.500 | ... | 3272 | 3021 | 2805 | 2617 | 2455 | 2310 | 2181 | 2066 | 1967 | 1870 | 1785 | 1707 | 1636 | 1510 | 1402 | 1309 | 1227 | 1091 | 984 | ... |
| | | ... | 0.123 | 0.144 | 0.167 | 0.192 | 0.218 | 0.246 | 0.276 | 0.308 | 0.341 | 0.376 | 0.413 | 0.450 | 0.491 | 0.576 | 0.668 | 0.767 | 0.873 | 1.104 | 1.363 | ... |
| | | ... | 26,600 | 21,000 | 16,750 | 13,600 | 11,170 | 9350 | 7900 | 6700 | 5760 | 4970 | 4300 | 3790 | 3330 | 2600 | 2100 | 1700 | 1400 | 975 | 720 | ... |
| 17/32" | 0.53125 | ... | 3925 | 3623 | 3364 | 3141 | 2944 | 2770 | 2617 | 2475 | 2355 | 2242 | 2144 | 2048 | 1962 | 1811 | 1682 | 1575 | 1472 | 1308 | 1177 | ... |
| | | ... | 0.116 | 0.135 | 0.157 | 0.180 | 0.205 | 0.232 | 0.260 | 0.289 | 0.320 | 0.354 | 0.388 | 0.424 | 0.462 | 0.542 | 0.628 | 0.721 | 0.820 | 1.040 | 1.283 | ... |
| | | ... | 33,800 | 26,800 | 21,400 | 17,400 | 14,360 | 11,940 | 10,000 | 8560 | 7350 | 6330 | 5520 | 4790 | 4220 | 3350 | 2670 | 2180 | 1790 | 1250 | 910 | ... |
| 9/16" | 0.5625 | ... | ... | 4301 | 3993 | 3727 | 3495 | 3289 | 3106 | 2943 | 2796 | 2662 | 2542 | 2431 | 2330 | 2150 | 1996 | 1804 | 1747 | 1553 | 1398 | 1271 |
| | | ... | ... | 0.128 | 0.148 | 0.170 | 0.194 | 0.219 | 0.245 | 0.273 | 0.304 | 0.335 | 0.365 | 0.400 | 0.436 | 0.512 | 0.594 | 0.681 | 0.774 | 0.982 | 1.212 | 1.460 |
| | | ... | ... | 33,600 | 27,000 | 21,900 | 18,000 | 15,000 | 12,670 | 10,770 | 9190 | 7940 | 7000 | 6000 | 5340 | 4170 | 3360 | 2730 | 2240 | 1580 | 1150 | 870 |
| 19/32" | 0.59375 | ... | ... | ... | 4700 | 4383 | 4109 | 3867 | 3652 | 3460 | 3287 | 3131 | 2988 | 2858 | 2739 | 2529 | 2348 | 2196 | 2054 | 1826 | 1643 | 1494 |
| | | ... | ... | ... | 0.141 | 0.161 | 0.183 | 0.207 | 0.232 | 0.259 | 0.287 | 0.317 | 0.347 | 0.380 | 0.413 | 0.485 | 0.562 | 0.645 | 0.734 | 0.934 | 1.158 | 1.388 |
| | | ... | ... | ... | 33,300 | 27,200 | 22,800 | 19,100 | 15,740 | 13,300 | 11,400 | 9870 | 8600 | 7500 | 6620 | 5200 | 4170 | 3400 | 2800 | 1960 | 1400 | 1075 |
| 5/8" | 0.625 | ... | ... | ... | ... | 5114 | 4793 | 4511 | 4261 | 4037 | 3835 | 3652 | 3486 | 3334 | 3196 | 2950 | 2740 | 2557 | 2397 | 2131 | 1918 | 1743 |
| | | ... | ... | ... | ... | 0.153 | 0.175 | 0.197 | 0.220 | 0.246 | 0.272 | 0.301 | 0.330 | 0.360 | 0.392 | 0.461 | 0.534 | 0.614 | 0.698 | 0.880 | 1.090 | 1.320 |
| | | ... | ... | ... | ... | 33,400 | 27,300 | 22,800 | 19,300 | 16,400 | 14,000 | 12,100 | 10,550 | 9200 | 8150 | 6350 | 5130 | 4160 | 3400 | 2420 | 1750 | 1319 |

constant, remains the same no matter what the fiber stress to which the spring is designed, and is applied in the same manner in all cases.

### Examples of Applications of the Tables

*Example 1*—A spring is made from No. 23 spring wire. It has a mean diameter of ¼ inch and 18 working coils. What weight is required to compress this spring 1 inch?

By referring to Table 1 it will be found that for a spring of the size wire and mean diameter specified, the constant is 36, and this divided by the number of working coils, (in this case 18), gives a weight of two pounds, which is required to compress the spring 1 inch.

*Example 2*—A spring is made from No. 24 wire and has a mean diameter of ¼ inch. How many coils are required in this spring to obtain a movement of 1 inch with a load of 1 pound?

By dividing the constant 25 by the load (one pound) the number of working coils required is found which in this case will equal 25.

Particular stress should be laid upon the point that the constant in all the tables is correct regardless of the fiber stress used, provided the spring has a movement of one inch or more.

*Example 3*—A spring is to be designed to work freely over a 1-inch diameter bar; it should have at least a 2-inch total movement, and should compress to a length of 2 inches without the coils touching each other. The spring should be capable of carrying a load of 44 pounds per inch of compression.

To work freely over a 1-inch diameter bar, the spring ought to be made from No. 8½ wire and have a mean diameter of 1¼ inch. Such a spring has a full-load capacity of 120 pounds. The constant is 440, and this constant divided by the load per inch of compression (44) gives the number of working coils required which, therefore, is 10. As the diameter of the wire is 5/32 inch, the solid height of the spring with closed ends added, will not be more than 1⅞ inch, so that the spring will compress to 2 inches without the coils touching each other, and will fill all requirements.

*Example 4*—What load is required to compress a spring 1 inch if it is made from ¼-inch wire having 1 inch mean diameter and 14 working coils?

Referring to Table 3 it will be seen that the constant for a spring as specified is 5625. This constant divided by 14 gives 401 pounds required to compress the spring 1 inch.

*Example 5*—What would be the free height of the spring specified in the preceding example?

By referring to Table 3, it will be found that for a spring of the dimensions specified, the movement per coil or the deflection is 0.109 inch. Add to this the diameter of the wire, 0.250 inch, giving a total space or lead of spring of 0.359 inch. This value multiplied by 14 gives 5.026 inches as the free height of a spring with 14 working coils. Add to this, if the ends are ground, one diameter of wire for the end coils (dead coils) giving a total free height of 5.276 inches. If the ends are not ground, add two diameters of wire.

* * *

## MICROMETER FOR SETTING BORING-BAR FLY CUTTERS

BY G. D. H.

In an article in the March number of MACHINERY, page 646, on the design of a micrometer for setting boring-bar fly cutters, it is stated that one hardened and ground steel disk is required for each size of hole to be bored. It is evident that if means were used for setting the spindle so that direct readings could be taken on the spindle in the regular way, starting at zero, it would be unnecessary to use a steel disk for making the measurements. By using a standard plug gage, the spindle may be set at zero and the reading of the required micrometer measurement for setting the fly cutters may be determined by the use of the following formula:

$$Y = B + \frac{A - 1.86603D}{1.73206}$$

in which $A$ = diameter of boring-bar;
$B$ = radius of hole;
$D$ = diameter of plug gage;
$Y$ = micrometer reading.

The position of the micrometer spindle will, of course, be the same no matter which method is employed, but if a plug gage is used for setting the spindle at zero, the distance $Y$, as shown in the accompanying diagram, will be the micrometer reading. This distance may first be readily found in terms of the diameter of an equivalent disk, that is, in terms of $X$, after which the value of $X$, as determined by the disk method, may be substituted in the formula. According to the previous article,

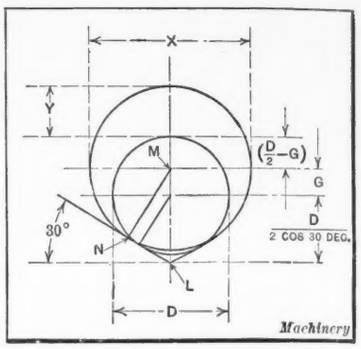



Diagram illustrating Use of Formula for setting the Micrometer Spindle

$$X = \frac{2B\ (\cos 30\ \text{deg.}) + A}{1 + \cos 30\ \text{deg.}} \qquad (1)$$

Then, referring to the diagram,

$$Y = \frac{X}{2} - \left(\frac{D}{2} - G\right) = \frac{X - D + 2G}{2} \qquad (2)$$

In the triangle $LMN$,

$$MN = \frac{X}{2} = \left(G + \frac{D}{2\ (\cos 30\ \text{deg.})}\right) \cos\ 30\ \text{deg.}$$

$$= G\ (\cos 30\ \text{deg.}) + \frac{D\ (\cos 30\ \text{deg.})}{2\ (\cos 30\ \text{deg.})}$$

from which

$$2G\ (\cos 30\ \text{deg.}) = X - D$$

and

$$G = \frac{X - D}{2\ (\cos 30\ \text{deg.})}$$

Substituting this value of $G$ in Equation (2),

$$Y = \frac{X - D + \dfrac{2\ (X - D)}{2\ (\cos 30\ \text{deg.})}}{2}$$

$$= \frac{(X - D)\ (\cos 30\ \text{deg.}) + (X - D)}{2\ (\cos 30\ \text{deg.})}$$

$$= \frac{(X - D)\ (1 + \cos 30\ \text{deg.})}{2\ (\cos 30\ \text{deg.})}$$

Substituting in this equation the value of $X$ in Equation (1),

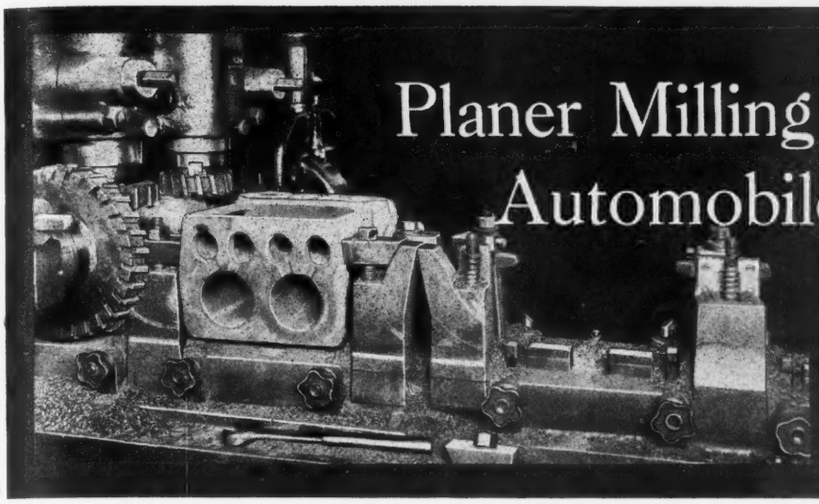
$$Y = \frac{\left(\dfrac{2B\ (\cos 30\ \text{deg.}) + A}{(1 + \cos 30\ \text{deg.})} - D\right)(1 + \cos 30\ \text{deg.})}{2\ (\cos 30\ \text{deg.})}$$

$$= \frac{2B\ (\cos 30\ \text{deg.}) + A - (1 + \cos 30\ \text{deg.})\ D}{2\ (\cos 30\ \text{deg.})}$$

That is,

$$Y = \frac{1.73206\,B + A - 1.86603D}{1.73206}$$

$$Y = B + \frac{A - 1.86603D}{1.73206}$$



# Planer Milling Practice in Automobile Plants

By Edward K. Hammond

**First of Two Articles Describing Methods of Milling Motor Car Engine Parts—This Installment Deals with Milling Operations on Crankcases**

ALTHOUGH the term "planer type" is quite generally employed to designate those milling machines furnished with a long table for carrying a number of pieces of work past milling cutters carried by heads supported on the cross-rail and housings, it is probably more accurate to call equipments of this general type by the name of multiple-spindle milling machines. They are especially adapted for use in milling large pieces of work, and it is the usual practice for the machines to be designed to meet the particular requirements of one class of work on which they are to be used continuously. For instance, machines of this type are very generally used in motor car manufacturing plants, in milling such parts as crankcases, cylinder blocks, cylinder heads, etc., and in almost every case the milling machine builder has been furnished with designs of the parts and detailed information concerning such matters as the daily production which is required, the average depth of cut to be taken on the different surfaces that must be milled, and other matters of a like nature. With these data at his disposal, he is able to design a machine which has the necessary number of spindles for milling the different finished surfaces on the work, and which is structurally adapted for the service required.

It may appear that data concerning the number of parts per day is information which need not be given to the milling machine designer, but as a matter of fact this is of great importance to the men who decide upon the way in which multiple-spindle milling machines are to be built for handling various special classes of work. Very little consideration need be given to this subject to make it apparent that if there is a large number of parts to be milled, the rate of production secured from the machines at once becomes a highly important factor, and so it will be well worth while for the plant making an investment in multiple-spindle milling machines to obtain equipment which is designed in such a way that as many surfaces as possible are milled simultaneously, thus giving as high a rate of production as possible. On the other hand, if the kind of work to be milled is limited in quantity, it may be found more desirable to perform several independent operations on one or more machines which are of simpler construction and therefore less expensive to buy. In the latter case, a more complicated equipment might be able to turn out the required production in, say, half of a full working day, but as the machine was especially designed for a specific class of work, it would lie idle for 50 per cent of the time, with the result that a poor return would be obtained on an unnecessarily heavy investment. These are the considerations which make it imperative for the designer to know all about the service which will be required of the finished milling machine.

### Features of Multiple-spindle Milling Machines

Owing to the fact that the work-holding fixtures for multiple-spindle milling machines are usually designed and made in the plant of the milling machine builder, it is safe to say that they are generally better adapted for the work than is the case with fixtures designed by less experienced men for use on other types of milling machines. When presenting this treatise dealing with the results obtained in production milling on various types of machines, it has been the intention to illustrate and describe fixtures and methods used for the performance of milling operations, after first giving a very brief review of the general characteristics of the type of machines on which the work is to be done. It is assumed that the general characteristics of the standard types of milling machines are matters of general mechanical knowledge, and so the question of machine design has not been taken up in detail. In the case of fixtures used on other types of milling machines, there are some cases shown in which certain criticisms of the fixture design are warranted. These fixtures for use on the multiple-spindle machines, however, have been designed by experts and are in practically every case ideal for their work. The idea of the following discussion is to describe some of those classes of work which are advantageously milled on multiple-spindle machines used in automobile factories, so that manufacturers in other lines who are milling parts of their product by less efficient methods may see how this type of equipment could be used to advantage in their factories.

In operating multiple-spindle milling machines, a number of fixtures are set up on the table, so that a "string" of castings may be passed between the milling cutters on the machine. This is a familiar sight to every experienced mechanic, but possibly the details of the way in which the work is set up and removed from the machine are not so well known. Owing to the large size of the pieces to be milled, it is generally found necessary to employ a machine operator and a helper, and these two men follow a definite routine in performing their work. It is quite a general practice to start the machine immediately after a casting has been set up in the fixture nearest to the milling cutters. Then the operator and his assistant will proceed to set up castings in each of the other fixtures, starting with the fixture next to the one in which the first piece was mounted. After all of the fixtures have been loaded, one or two of the pieces carried at the front end of the table will have passed under

the cutters, and so the men engaged to run the machine can immediately busy themselves with removing these milled pieces. The advantage of this plan is that idle time of the operator is eliminated, because he does not first load the fixture and then have nothing to do during the time that the work is being fed under the cutters, as is the case with some types of single-spindle machines.

About the only lost time of the operator is represented by that period during which the last piece of work is being fed past the cutters. When all of the fixtures have been emptied, the table is returned to its starting position, the power-driven rapid traverse movement being employed so that very little time is required. Then the operators immediately set up another piece of work in the first fixture and use the rapid traverse to run this piece up almost into engagement with the milling cutters, after which the feed movement is engaged. The operators then start to reload the remaining fixtures in the order which has already been explained. In addition to keeping the operators of the machine constantly

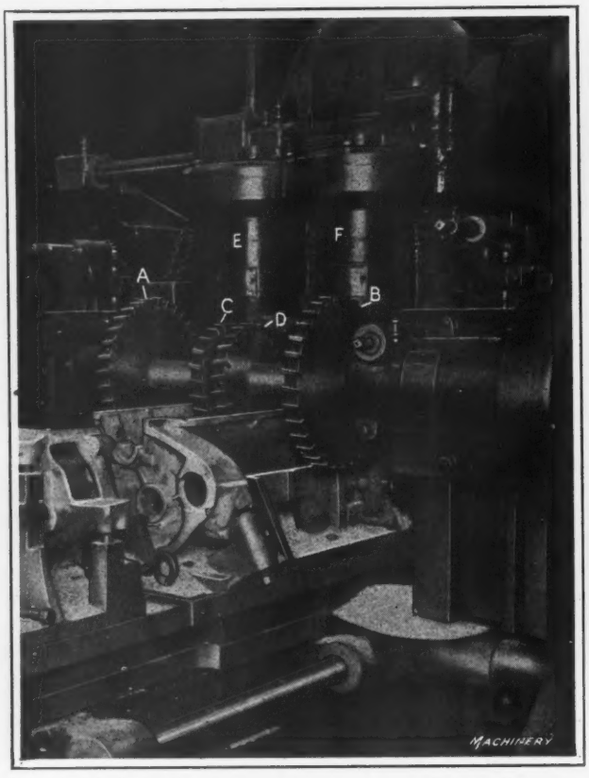



Fig. 1. View of Two Table Sections and Roughing Cutters on Beaman & Smith Machine milling Hudson Crankcases

employed, it will be apparent from the preceding description that the idle time of the machine also is cut down to a minimum, which comprises the period required to unload the last piece of work, return the table to the starting point, and set up the other casting in the first fixture. Consequently, it is obvious that machines of this type, although they are usually quite expensive, are able to attain a very high rate of production and thus pay a good return upon the investment.

### Importance of Care in Designing Work-holding Fixtures

Equal care must be given to the designing of the work-holding fixtures and the machines on which they are to be used, if anything approaching maximum operating efficiency is to be attained. On average classes of work, it is possible to operate multiple-spindle milling machines at a feed of from 8 to 9 inches per minute, and in working out the fixture design, this factor must be constantly borne in mind. In other words, the tool designer must first determine the amount of time it will take to feed each piece of work past the cutters, and then he must work out the design of all adjustable supporting points and clamping mechanisms on the fixture in such a way that the machine operator and his assistant will be able to set up a piece of work ready for milling in a period not exceeding the length of time required to feed another piece of work past the cutters. If this result is not obtained, the setting-up time becomes the limiting factor in determining the quantity of production that can be secured.

### Application of the Three-point Suspension Principle

Multiple-spindle milling machines are used for the performance of both first and second operations on the work, and the design of fixtures will naturally be governed by the nature of the operation which is to be performed. The pieces milled on these machines are usually of considerable size, and so where the first operation is to be performed with the work located on the fixture on a rough cast or forged surface, it is a general practice to employ what is known as a "three-point suspension" bearing. This is based upon the familiar principle of geometry that three points deter-

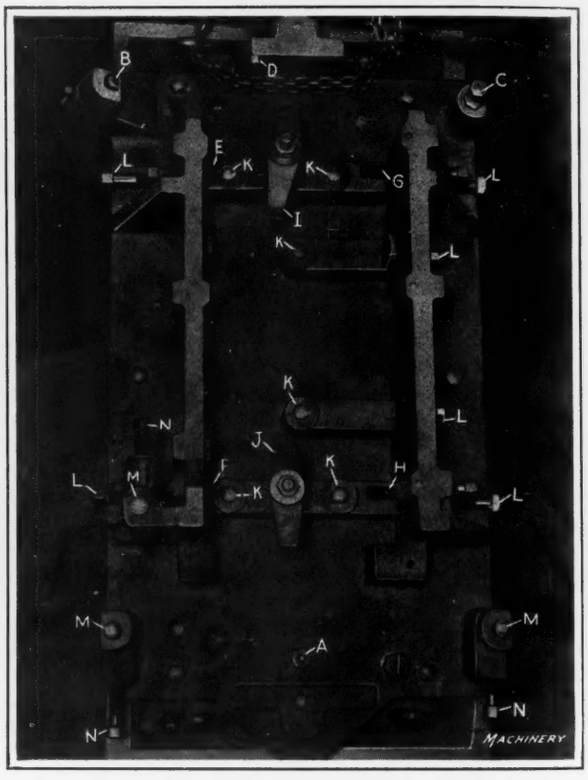



Fig. 2. Close View of Work-holding Fixture of Type used to hold Crankcases on Machine shown in Fig. 1

mine a plane. To use a simple comparison, a three-legged stool will stand firmly on a floor, regardless of how rough it may be; but a four-legged stool will have one leg off the floor and be liable to rock about, if there is any lack of uniformity in the surface. It is exactly the same way in setting up a rough casting for the first machining operation: with the three-point suspension, the casting is sure to be firmly supported, but if four or more supporting points are used, the casting is likely to tilt out of place. In some cases, the cast surface of the work may be used as a locating point, while in other instances it may be found desirable to cast bosses on the work, which come into contact with locating points provided on the fixture for that purpose.

Obviously, the location obtained for a first operation of this character is not extremely accurate, and in almost every case the method of procedure is to use the finished surface milled by the first operation as the locating point in setting up the work for the performance of subsequent operations, thus bringing other finished surfaces into an accurate relationship with the one first milled, and consequently with each other. As a result, it becomes imperative that the first finished surface shall be held within close limits of accuracy;

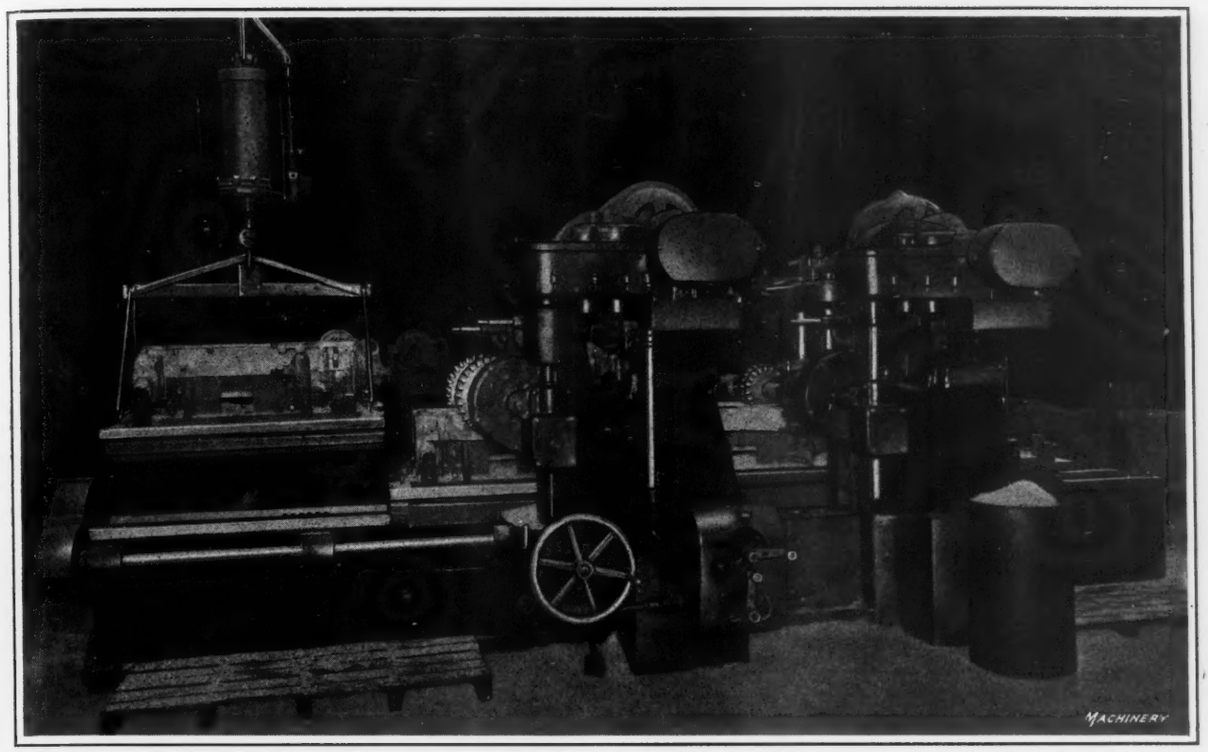


Fig. 3. View of Beaman & Smith Machine for milling Hudson Crankcases. This Illustration shows One of the Table Sections being returned to the Starting End of the Bed

and to accomplish this result, it is necessary for the work to be fully supported at all points. In the case of such pieces as cylinder blocks, it is not usually necessary to provide special means of support, because the form of the work is such that there is little danger of deflection resulting from the pressure applied by the milling cutters. For milling crankcases and other work of this general character, however, where the castings are thin, and where there are flanges and arms on the work, which have a considerable amount of overhang, it is absolutely imperative to have all such unsupported members held in a way which will adequately resist the cutting pressure.

### Compensation for Variations in Size of Forgings and Castings

It must be borne in mind in this connection that the work is being located from a cast or forged surface, and that there may be as much as 1/8 inch variation in a casting, or 1/16 inch variation in a forging, which is produced under the best possible conditions. Consequently, it is out of the question to provide fixed supports on the fixture to come into engagement with the work. The three points of the three-point suspension bearing are rigidly fixed, but all other supporting members must be made adjustable, so that after the casting is dropped into place on the three fixed points, these adjustable points can be brought up into engagement with the work and then securely clamped in this position. Commonly used forms of construction for this purpose are to either have plungers supported by compression springs, or plungers which rest upon a sliding tapered surface at their lower end, with a screw for the purpose of manipulation. Where either of these designs is used, the plunger is brought up into engagement with the section of the work which it is to support and then firmly clamped in this position by means of a screw. After the first operation has been performed, it has been mentioned that the milled surface may be used as a locating point for subsequent operations. If this surface has been milled without springing the work, there will be a perfectly plane surface to use for locating the piece ready for performing the next operation, and so any required number of points may be provided on the fixture to afford the necessary support. It is usually important to provide for locating the work in certain other directions also, depending on the form of the pieces being milled.

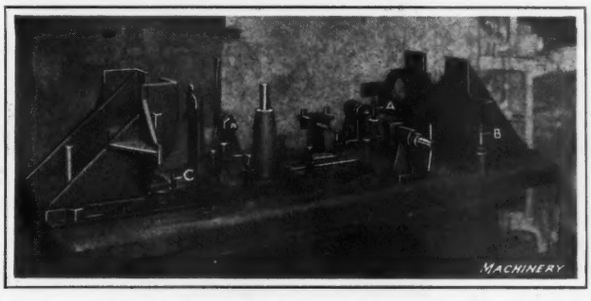


Fig. 4. Inspection Fixture used for checking up Hudson Crankcase Castings to see that Sufficient Metal is provided to "clean up" all Machined Surfaces

### Cutting Speeds for Planer Milling Machines

In examining the speeds at which the cutters are commonly driven on planer type milling machines, it will probably be found that 60 feet per minute represents an approximate average. If the cutters are properly designed, and if the necessary precautions are taken to provide for the dissipation of heat which is generated in cutting the metal, it will be found that this figure can be substantially increased. The contention is made that the chips usually produced by cutters operated on machines of this type are fine, and that each edge of the tool is usually in action for not more than 5 per cent of the running time; that is to say, each edge on the cutter is working for 5 per cent of a revolution and has the remaining 95 per cent of the revolution during which the coolant can absorb heat. When very high speeds are employed, it is important for the arbors on which the cutters are mounted to be of ample size and for plenty of power to be provided for driving the milling machine. Most of the planer type milling machines that are being built today are provided with ample power and strength to enable the best types of high-speed steel milling cutters to be driven to their maximum productive capacity. There is, however, a point that is sometimes overlooked by users of these machines, namely, the necessity of mounting milling cut-

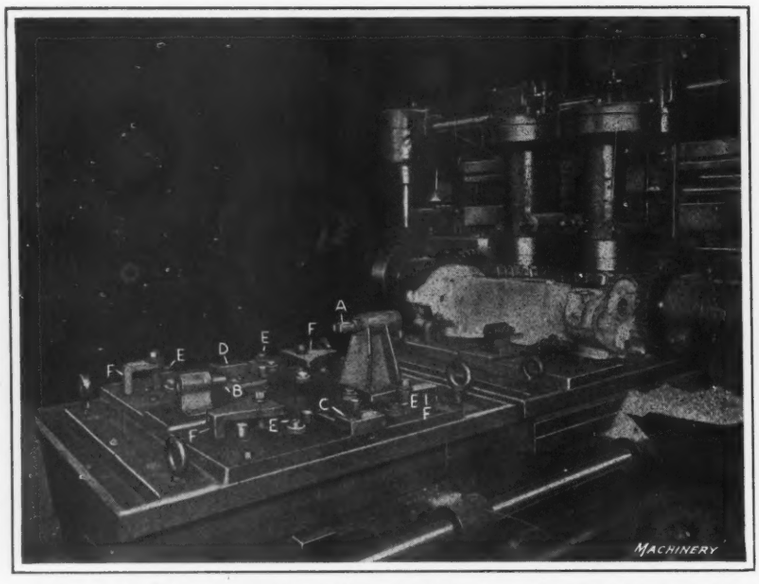



Fig. 5. Close View of Roughing Cutters and Fixture for milling Cylinder Face and Ends of Hudson Crankcases

ters upon an arbor of sufficient size to withstand the severe torsional and bending stresses to which it is subjected. As a general proposition, the capacity of the cutters represents the limiting factor upon the rate of production attained by planer type milling machines; but if an arbor of insufficient size is used, it will be apparent that this carelessness on the part of the tool designer places a serious handicap upon the amount of work which the machine can turn out in a specified period of operation.

### Types of Beaman & Smith Planer Type Milling Machines

A multiple-spindle or "planer" type of milling machine is built by the Beaman & Smith Co., Providence, R. I., which possesses the usual features of an equipment of this kind, in addition to which provision is made for eliminating the idle time of the machine which would ordinarily occur while the operator is removing the work from the last one or two fixtures, returning the table to the starting position, and setting up a casting in the first fixture on the table ready for starting the next cut. This result is secured through having the table made in sections of sufficient size to just allow a single work-holding fixture to be mounted on each section of the table. With such an arrangement, each fixture may be unloaded after the work has passed under the milling cutters and the table is then picked up by a trolley hoist and carried around to the opposite end of the milling machine bed, where it is again lowered into place on the ways. Where a planer type milling machine is designed and used on this principle, the operation becomes absolutely continuous, owing to the avoidance of the necessity of reversing the machine to bring a table equipped with a string of fixtures back to the starting point. Beaman & Smith planer type milling machines built along these lines are used in the plant of the Hudson Motor Car Co., of Detroit, Mich., for milling crankcases and cylinder blocks, and they are the means of permitting machining operations on these parts to be performed under extremely advantageous conditions.

Another feature of the design of Beaman & Smith milling machines is the provision which has been made for performing roughing and finishing operations on each piece of work without requiring any resetting. In order to enable such results to be obtained, it will be seen from Fig. 3 and some of the following illustrations that the machines equipped for the performance of these combination roughing and finishing operations are furnished with two sets of housings and cutter-heads. The rough castings are passed between the first set of cutters to remove most of the surplus metal, leaving approximately 0.020 inch for removal by a similar set of cutters carried on housings which are located a short distance further along the bed of the machine. Where considerable accuracy is required on any large surfaces that are milled on machines of this type, it will be apparent that the use of this combination of roughing and finishing cutters is the means of effecting a substantial improvement in the quality of workmanship that is secured. At the plant of the Hudson Motor Car Co. where this method is employed, milled surfaces on cylinder blocks and crankcases do not receive any further treatment, and it is safe to say that the work can be done far more economically in this way than where castings are rough-milled and then subjected to a subsequent finishing operation by grinding or by some similar method.

### Milling Hudson "Super-Six" and "Essex" Crankcases

Milling operations that are involved in machining aluminum crankcases for both the Hudson "Super-Six" and for the new "Essex" cars are performed on two Beaman & Smith planer type milling machines, each of which is equipped with the subdivided tables and the arrangement of roughing and finishing cutters which have just been described. On the first machine, the base of the crankcase, the pads on the suspension arms, and the seats for the crankshaft bearing caps are rough-milled, and the base and bearing cap seats are also finish-milled by cutters carried by the other set of housings. Then the work is taken to a second machine, which rough-mills both ends of the crankcase and the top surface to which the cylinder block is bolted, and then finish-mills the top surface. Having made this general statement of the method of procedure in handling the work, a detailed description can be presented of the work-holding fixtures and the routine followed in handling the work.

It will be apparent from Fig. 1 that the large inserted-tooth cutters *A* and *B* provide for milling the pads on the

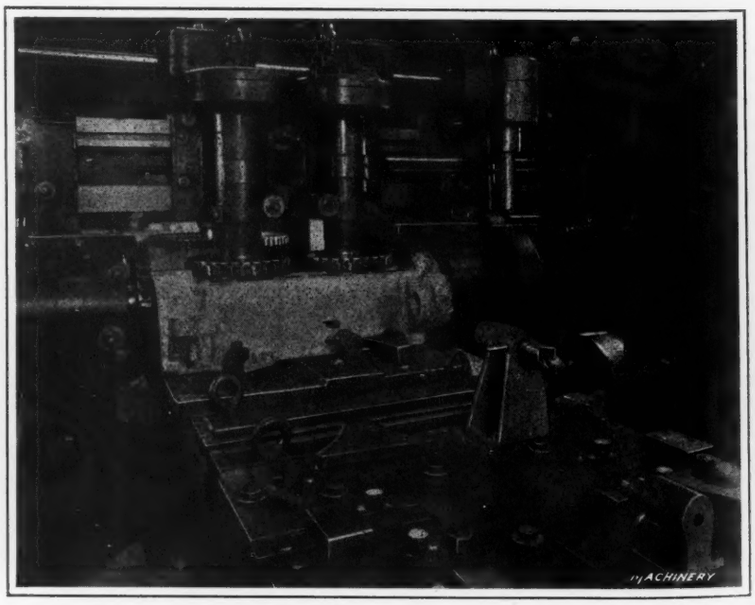



Fig. 6. End View of Machine and Fixture shown in Fig. 5, including View of Finishing Cutter that is used to mill the Cylinder Face of the Crankcase

suspension arms at either side of the crankcase, by means of which the motor is supported on the chassis; and the two smaller cutters *C* and *D* mill seats for the crankshaft bearing caps. The base of the crankcase is also milled by two other cutters which are not shown but which are mounted on vertical spindles carried in bearings *E* and *F*. After each crankcase passes under this first set of six cutters, the table which carries the work-holding fixture is traversed along the bed of the machine to provide for feeding the work under a second set of four cutters, which is carried on the other housings. These cutters perform a finish-milling operation on the base of the crankcase and on the crankshaft bearing cap seats, both the roughing and finishing operations being performed without interruption. After these milling operations have been completed, the casting is removed from the work-holding fixture, and four hooks, which are located at the ends of chains carried by a trolley hoist, are passed through rings at the corners of the table. The table is then lifted off the bed of the milling machine and carried around on a crescent-shaped trolley rail, which brings it back to the front end of the bed, where it is lowered into place on the ways. Beneath the table there is a rack which meshes with worms carried by a shaft inside the bed of the machine. These driving worms are mounted along the shaft at sufficiently frequent intervals so that each table will be fully engaged by one worm before it starts to run off the preceding worm. In this way, there is assurance of always having ample power available to drive the work between the milling cutters.

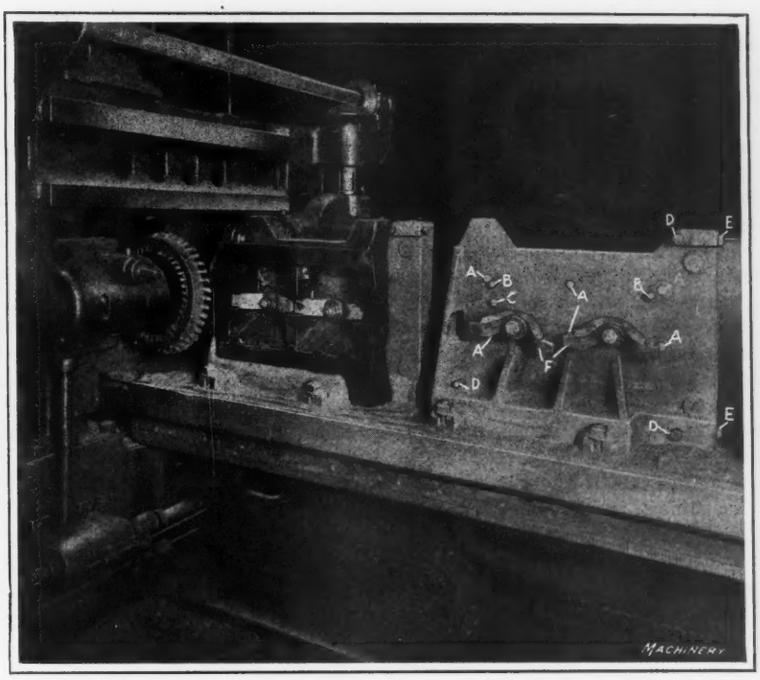



Fig. 8. Opposite Side of Fixture shown in Fig. 7. The Oil-pan Face of the Crankcase is milled at this Side and the Cylinder Block Face at the Opposite Side of the Fixture

As this is the first machining operation performed on these crankcase castings, the work-holding fixtures are designed with a three-point suspension bearing on which the work is located from the rough cast surface. The three suspension points of the fixture will be seen at *A*, *B*, and *C* in Fig. 2. It will be apparent that as the work is fed between the milling cutters, a considerable amount of end thrust is developed, and provision must be made in designing the work-holding fixture to afford means of carrying this load. Such provision has been made by placing in the body of the fixture a bolt *D*, against which the end of the casting rests so that there is no possibility of its sliding longitudinally in the fixture. Sidewise location is secured by means of two fixed screws *E* and *F*, against which the casting is forced by means of adjustable screws *G* and *H*. The work is held down by means of straps *I* and *J*.

Mention has been made of the necessity of providing adjustable supporting points for engaging the lower surfaces of large castings which are sufficiently thin so that there would be danger of springing the work under pressure developed by the cut. Aluminum crankcase castings are a typical example of work which requires very careful support to avoid trouble of this kind. Not only is the work quite thin, but there are long overhanging members which are very inadequately supported from the main part of the casting. In designing the work-holding fixture shown in Fig. 2, means have been provided for supporting the work by six adjustable plungers *K* which are raised into contact with the casting after it has been dropped into the fixture. These plungers are manipulated by means of screws *L* which control the movement of wedges that slide under the beveled ends of plungers *K*. It will be apparent that as these wedges are held under the ends of the plungers by means of screws *L*, they not only force the plungers up into engagement with the work, but also provide for holding them rigidly in that position, thus affording adequate support for the pressure exerted by the milling cutters. In addition to plungers *K*, there are three spring plungers *M* which are held in contact with the work at the time it is placed in the fixture by means of compression springs located beneath these plungers. When the casting has been put in place, these plungers are firmly located against the work and then clamped in this position by means of binding screws *N*.

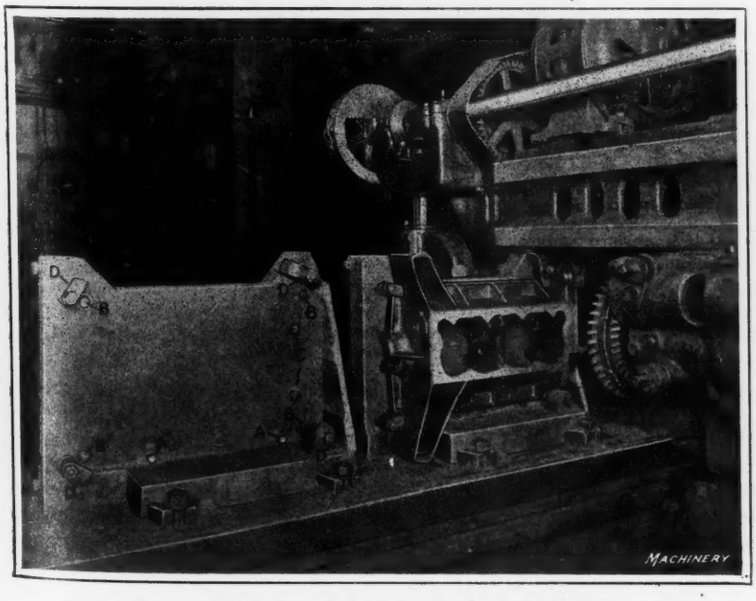



Fig. 7. Fixture used by the Studebaker Corporation for simultaneously milling Opposite Sides of Cast-iron Crankcases on Ingersoll Machine

### Gaging Castings before Starting Machining Operations

Some foundries make it a rule not to allow credit for any defective castings upon which machining operations have been started; but regardless of whether or not this is a rule of the foundry which delivers castings to a machine shop, that shop will be wise to follow the practice of carefully inspecting all of its castings before work is started. It is, of

course, desirable to obtain credit from the foundry for any castings which are of such poor quality that they cannot be successfully machined, but the saving effected through getting such credit for defective castings often represents but a very small percentage of the actual loss which would be suffered by the manufacturer if he proceeded with the machining operations until the work reached a point where the defect in the casting made it impossible to "clean up" some surface.

Recognizing the importance of this point, the Hudson Motor Car Co. uses a crankcase casting inspection fixture in connection with the Beaman & Smith multiple-spindle type of milling machines shown in Figs. 1 to 6, inclusive. This fixture, as illustrated in Fig. 4, is provided with three suspension points *A*, *B*, and *C*, corresponding to the points in the work-holding fixture shown in Fig. 2, on which a preliminary location of the casting is obtained. This fixture is used for ascertaining whether the foundry has allowed sufficient metal on all surfaces of the castings that are to be machined, so that they can "clean up" properly. In order to give a general idea of the use of this inspection fixture, the following points are mentioned: It will be apparent that on the bed of the fixture there are eight spring plungers, the purpose of which is to come up against the lower surface of the crankcase. These plungers are graduated on their stems to indicate the amount of excess metal which has been left for machining. It will also be seen that gages are provided at each end of the fixture, which have the same outline as the crankshaft bearing cap seats in the castings; and similar gages provide for checking up the surfaces which have to be machined on the suspension arms. Each crankcase casting is inspected on this fixture before it goes on to the milling machine. Not only does the use of this method make it possible to get credit for all defective castings, but, what is far more important, it also saves the loss resulting from the performance of milling operations on defective castings which could never be machined in a way that would enable them to pass the final inspectors.

### Performance of the Second Operation on Crankcases

The second operation performed on Hudson crankcases consists of rough-milling both ends of the crankcase and the face to which the cylinder block is bolted; and after this part of the work has been done, a finish-milling operation is performed on the cylinder block face. A multiple-spindle Beaman & Smith planer type milling machine, equipped with sectional tables and two sets of housings to carry rough- and finish-milling cutters, is used for the performance of this operation. The machine is shown in Figs. 5 and 6. It will be seen that four cutters are used for the roughing operation. An interesting feature of this set-up is that the two large inserted-tooth milling cutters which mill the top surface of the work have interlocking teeth. Quite obviously, this arrangement is necessary because if the teeth on one cutter did not overlap those on the other, there would be a seam left on the work at the point where the two cutters failed to meet. After the castings pass under these cutters, they are carried on to a single inserted-tooth milling cutter which is of sufficient size to extend completely across the surface to which the cylinder block is bolted. This large cutter can be clearly seen in Fig. 6, and it is used in place of the two interlocking mills, because greater accuracy can be obtained in finishing the cylinder block seat in this way. The finish-milling operation is not performed on the ends of the crankcase.

In connection with the work-holding fixtures used on this machine, there is one especially interesting feature of tool design, namely, that the same fixtures may be utilized for milling crankcases for either the Hudson "Super-Six" or for the new "Essex" car. The possibility of using the same tool equipment for these two jobs naturally is the means of saving the cost of an additional set of fixtures; and a further advantage of this practice is that a machine may be converted over from the performance of milling operations on one type of crankcase to the other with less loss of time than would be required if it were necessary to remove one set of fixtures and substitute others in their places.

It will be recalled that the usual practice in designing work-holding fixtures for the performance of second milling operations on large-sized pieces of work is to use a previously milled surface of the work as a locating point for subsequent operations. This is the method of procedure followed in designing the work-holding fixtures shown in Figs. 5 and 6; and where this method may be employed, it is usually possible to make a fixture of quite simple design. There are fixed pads on the bed of each fixture, which engage with the milled lower surface of the crankcase, and endwise location of the work is obtained by means of a V-block that fits over a projection on the side of each casting. In order to have the ends of the cases milled square with the crankshaft bearings, it is also important to locate the work from these bearings. This is done by using as locating points the seats which were milled during the preceding operation to receive the crankshaft bearing caps. These milled seats drop over blocks on the fixtures, and the work is now located in the desired position. To provide for clamping it down ready for milling, it is merely necessary to tighten up four straps on the flange running around the lower faces of the crankcase.

Having made a general statement of how these fixtures operate, we are in a position to explain the way that provision has been made for milling two styles of crankcases on the same fixture. It will be seen in Fig. 5 that there are two V-blocks *A* and *B*. Block *A* is used to provide longitudinal location for the Hudson "Super-Six" crankcase, while block *B* is used for locating the "Essex" case. Blocks *C* and *D* enter the crankshaft bearing cap seats to provide for locating the work so that the ends of the crankcase will be milled square with the crankshaft bearings. These blocks are of the proper size to enter the seats milled in both "Super-Six" and "Essex" cases; but as the "Essex" case is considerably the shorter of the two, it is necessary to provide longitudinal adjustment for blocks *C* and *D* so that they may be set in the desired positions for locating work of two different lengths. The slides provided for making this longitudinal adjustment of the locating blocks are clearly shown in Fig. 5.

There are nineteen cylindrical shaped locating pads by which the work is supported on the fixture. Attention is called to the fact, however, that all of these are not used at the same time; there are eight pads placed in the proper positions for supporting the "Essex" crankcase, and eleven that are properly situated to engage the previously milled lower surface of the "Super-Six" crankcase. In setting up the machine to mill "Essex" crankcases, it is necessary to remove the four end pads *E* for the "Super-Six" case, because these stops would interfere with the milling cutters that face off the ends of the castings. It will be apparent that pads *E* are bored at the center to receive screws which secure them down upon the bed of the fixture. Straps *F* provide for holding down both the "Essex" and "Super-Six" crankcases, as they are properly positioned for holding either size of work.

### Production Obtained in Milling Hudson "Super-Six" and "Essex" Crankcases

For the first operation on Hudson crankcases, which, it will be recalled, consists of rough- and finish-milling the crankshaft bearing caps, the suspension arm pads, and the face to which the oil-pan will be bolted, the work is fed to the cutters at a rate of 15 inches per minute, and the largest size cutters are driven at a peripheral speed of 520 feet per minute. The crankcase castings are made of aluminum, and the rate of production obtained is 130 milled cases in an eight-hour working day. For the second operation, which provides for rough- and finish-milling both ends of the

crankcases and the face to which the cylinder block will be bolted, the work is fed to the cutters at a rate of 30 inches per minute, and the cutters are driven at such a speed that the 32-inch cutter which finish-mills the cylinder block face is cutting at a speed of 503 feet per minute. On this operation, the rate of production obtained is 200 milled crankcases in an eight-hour working day. Four work-holding fixtures and table sections are provided for use on the machines which perform the first and second milling operations on crankcases.

### Simultaneous Performance of First and Second Operations on Studebaker Crankcases

In the plant of the Studebaker Corporation, in Detroit, Mich., use is made of a very efficient form of work-holding fixture which provides for simultaneously performing the first and second milling operations on cast-iron crankcases which are held at opposite sides of a vertical work-holding fixture. A good idea of the design of this equipment will be gathered from Figs. 7 and 8, where it will be seen that the fixture consists essentially of a plate supported edgewise on the table of a multiple-spindle milling machine built by the Ingersoll Milling Machine Co., Rockford, Ill., and furnished with the necessary clamping mechanism to provide for operating on a crankcase held at either side of the fixture. It will be evident that the first operation consists of milling the face of the crankcase to which the cylinder block will be bolted; and after this operation has been performed, the crankcase is removed from the fixture, and after being turned over, it is again set up at the opposite side of the fixture to provide for milling the oil-pan face of the crankcase. The illustrations will make it perfectly apparent that a side-head is mounted on each housing of the machine to provide for simultaneously taking these two cuts on the work.

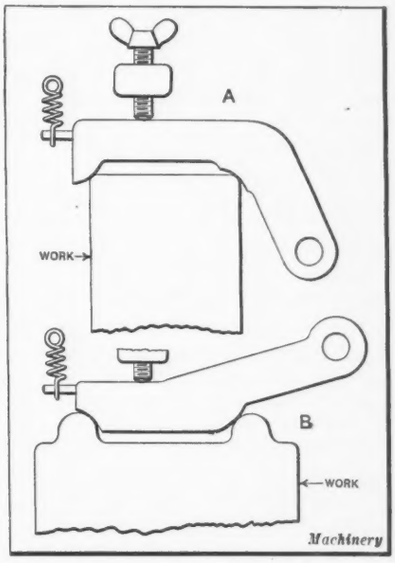
For performing the first operation on Studebaker crankcases, with the work held in the fixture shown in Fig. 7, it will be apparent that the work is located from the oil-pan face of the crankcase. In locating the rough castings in a fixture, it is the usual practice to employ a three-point suspension bearing, but in this case, such a design did not appear to be practical. Owing to the fact that four corners of the work are used for location, it is necessary for the machine operator to first check up the accuracy of his castings with a gage, and if it is found necessary, he grinds down one corner with a portable electric grinding machine until the work will rest firmly against the surface plate without rocking. In setting up a casting on the fixture shown in Fig. 7, the lower edge of the crankcase is set on two pins *A*, after which the case is pushed back against the fixture so that the four corners may be supported by pads *B*. To provide for carrying the end thrust of the milling cutters, the inside of the front end of each casting rests against two pins *C*, which are provided in the fixture for that purpose, and three straps *D* and a clamping screw hold the work back against the four supporting pads *B*. It takes approximately one minute to set up each casting in its fixture for performing the first operation, and the work is fed to the milling cutters at the rate of 4 inches per minute. The cutters are 16 inches in diameter and run at a speed of 18 revolutions per minute, which corresponds to a cutting speed of 75.5 feet per minute. Four castings are set up at each side of the fixtures for each traverse of the table. The first operation is performed on seven and one-half crankcases per hour.

Each casting that is carried by the fixture shown in Fig. 7 is fed past an inserted-tooth milling cutter which faces off the cylinder block face of the crankcase, after which the casting is removed from the fixture and carried around to the opposite side of the machine. Then after the work-holding fixtures have been unloaded at that side, the partially milled castings are set up, using the milled cylinder block seat as a locating point. Six fixed locating pads *A*, Fig. 8, are provided on the fixture to engage the milled face of the work. The casting is slipped over two pins *B* which hold it up in the desired position until the clamps are tightened, and a third pin *C* engages the inside of the casting at the forward end to support the thrust developed by the milling cutters. It is necessary to provide for supporting each of the suspension arms of the crankcase, in order to prevent distortion resulting from the pressure exerted by the milling cutters; and for this purpose three spring plungers *D* are used, which come up into engagement with the work at the time that it is placed in the fixture. Each of these plungers is then clamped in the desired position by means of a screw *E* furnished for that purpose, the screw for bolting the pin at the front end of the fixture not being shown in the illustration. With the casting set up and located in this way, it is clamped back onto the fixture by means of two straps *F* which are made semi-cylindrical in form so that they fit the crankshaft bearings. These straps are furnished with V-shaped slots and they are dropped over the bolts, instead of having the bolts enter holes drilled through the straps, the purpose being to enable the straps to be lifted off the bolts after the nuts have been slightly loosened. This saves a large part of the time which would otherwise be required to screw the nuts all the way off the bolts in order to remove the straps and allow the castings to be lifted off the fixtures. As in the case of the first operation, the work is done at a cutting speed of 75.5 feet per minute, with a feed of 4 inches per minute, and the rate of production is seven and one-half completely milled crankcases per hour.

* * *

## SWING VEES IN JIGS AND FIXTURES

On page 462 of the January number of MACHINERY, several applications of swing vees for locating and holding work in jigs and fixtures were described. It was shown how to locate the vees in order to provide for minimum variations laterally, due to differences in the height of the work. The accompanying illustration shows an idea along the same line; it will be seen that by curving the faces of the vees as shown, work of various heights may be clamped with no variation whatever in lateral position. This result can be obtained only when the points of contact on the work are two points or arcs of small radius. If the locating points were elements of the same circular arc, the work would have a tendency to move laterally.




Swing Vees with Curved Clamping Faces

G. C. H.

* * *

## NEED FOR SYSTEMATIC TRAINING OF WORKERS

In the United States there are approximately 6000 factories employing more than 250 men or women each. In these, systematic methods of training for the work to be done have been installed in less than 300 factories. One of the main problems facing the industries in the near future is that of training workers for the tasks they are to perform, and it is believed that the efficiency and production of American factories could be greatly increased if the work to be done were properly studied, the facilities by which it is done improved, and the workers trained to do the work in the most effective way.

# Conditions in the Machine Tool Trade

THE disposal of the government-owned machine tools naturally still remains one of the most important considerations in the machine tool field. The appointment of Charles E. Hildreth as chief of the Machine Tool Sales Division of the Ordnance Department is reassuring to the trade, because the matter of the disposal of the surplus machine tools will be handled by a man having exactly the experience and judgment that is required to deal with this difficult problem of the Government. Doubtless the government arsenals will absorb a considerable quantity of the machine tools on hand and the remainder will be disposed of in a manner most advantageous to the Government and at the same time with the least possible interference with the regular trade channels. The exact conditions of the disposal of these machines are not yet decided upon, but an inventory will be made and methods agreed upon with a view to safeguarding all the interests involved.

### The Price Situation

While the machine tool trade in general is not active, the majority of both manufacturers and dealers report an improvement over previous months. The automobile, the tractor, and the agricultural machinery manufacturers are the main buyers. It is expected that the reductions in prices that have taken place will be the final reductions, and in some instances there have already been hints that some of the reductions were too great and that an increase may soon prove necessary. The lines that have not yet reduced prices are not likely to do so, especially as in some instances the increase in prices during the war period was not commensurate with the increase in labor and materials; so that, while in some cases the increases doubtless were too great, there are other instances to be recorded where the increase provided too small a margin, and where, as there is no likelihood of any early changes in the cost of production, increases might become necessary in the future. At any rate, it is safe to say that the current prices represent a low level for a long time to come, if the machine tool trade is to remain in a healthy state.

In the case of cranes, prices have been reduced as much as from 30 to 35 per cent since the armistice, but crane manufacturers expect a rise in prices in three or four months, and it is believed that buyers who place orders now will be able to buy most advantageously.

### Prompt Payment of Claims Against Government a Necessity

The financial situation in many industries is not as satisfactory as could be desired. Collections are slow, the reason given being that many manufacturers are awaiting settlement of claims on the part of the Government. Several large concerns are unable to go ahead with the plans that they had laid for peace work because they will not have the ready cash to put into new developments until the Government has settled its bills. A prompt settlement of all claims would help tremendously to improve the industrial situation, and the Government can do no greater harm to the industries of the nation as a whole than by delaying the settlements of just and reasonable claims. Reports indicate that hundreds of millions of dollars are in this manner withheld from the industries, and it is apparent that this must cause considerable stagnation in the commercial field. Everybody is ready to go ahead and great plans are laid for the future. The sooner these plans can be carried out, the better.

### The Foreign Trade in Machine Tools

It is reported that American machine tools owned by the United States Government have been sold in Belgium at 10 per cent below the current market price and that in some instances payments have been extended over a period of as much as three years. As a result of this, it is said that a number of contracts for machine tools for Belgium that had recently been placed in the United States have been cancelled. How serious the effect of the sale of machine tools owned by the United States Government will prove in the foreign market is difficult to forecast, as the amount of machinery to be disposed of and the policy of the Government are not known, but unquestionably the market will be considerably demoralized if these machines are sold below the current market quotations.

The trade with Belgium is beginning to become more active, several manufacturers reporting that orders have been taken and shipments made for Belgian customers. The French restrictions also appear to be somewhat less rigidly enforced, and the War Trade Board has announced that the restrictions upon importation into Great Britain of machine tools, and of tools and appliances, in general, used in the metal-working trades, have been removed, and that such machines, accessories, tools, and appliances may now be imported freely under a general license.

Many manufacturers are working on stock, but as both the domestic and foreign dealers have very little stock on hand this is not a serious condition in most cases. With the regular business that is coming in and the stock orders from dealers, many manufacturers are working full force and full time.

### Automobile Parts Manufacture

The prices of automobile parts were reduced considerably in the early part of the year, due to the pressure brought upon the part manufacturers by the automobile builders. The automobile companies have been buying parts only as they needed them, laying in a couple of months supplies instead of providing for half a year's business, as has formerly been the practice. Expecting further drops in the part prices, the automobile manufacturers are following a careful buying policy. The part manufacturers, however, report that while it is likely that there will be still more price reductions in certain lines, prices will come back to some extent in a few months, at which time there will be heavy buying. The automobile manufacturers are not yet ready for the full volume of peace business, but when that time comes, a brisk revival of the parts trade is to be expected, and with it will come a greater demand for machine tools.

### Labor Conditions

There has been some unrest among labor in the machine tool field and a few strikes have taken place in the Middle West during the month, with threats of strikes elsewhere. The time, however, is not opportune for the strikers, because manufacturers of machine tools are in a position to close down their plants for some time without greatly inconveniencing themselves, on account of the general dullness of the trade. The strikes that have taken place have not, in general, been on account of working hours or wages, but have largely been a matter of recognition of the union. They appear to have been wholly the work of outside influence and not caused by any dissatisfaction with local conditions on the part of the employes. It is to be hoped that the differences that exist may be settled amicably between the employers and the employes, because more can be gained on both sides by cooperation and amicable settlements than by strikes and the attendant loss to both the manufacturers and the men.

# LETTERS ON PRACTICAL SUBJECTS

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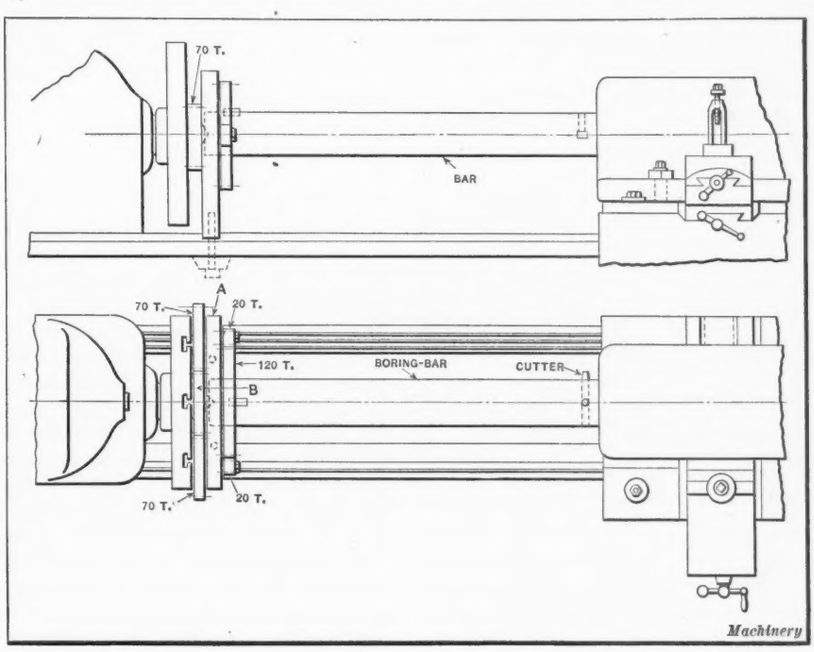
## LATHE ATTACHMENT FOR CUTTING A SIX-INCH LEAD THREAD

The attachment illustrated and described in the following was devised to perform an unusual threading operation on a 24-inch Lodge & Shipley lathe. Two bronze nuts, used to drive the heads of a large planer, were to be threaded with a quadruple 6-inch lead Acme thread. The nuts were 4 feet long and had a 4¾-inch bore. The lathe which most nearly approached the capacity required for this job was capable of cutting threads only up to 1 inch lead, the lead-screw revolving twice to one revolution of the lathe spindle. In order to obtain the required results, it would be necessary to increase the speed of the lead-screw, so as to produce a ratio of 12 to 1 between the lead-screw and the spindle. This speed was too great for the lead-screw; however, the device shown in the illustration was employed, whereby, by gearing down the speed of the boring-bar, the job was performed satisfactorily.

The device consists of a plate *A*, 2 inches thick and 20 inches square, carrying the gearing as shown. Plate *A* was planed all over and provided with V-grooves on the lower side to fit the vees on the lathe. Two holes were drilled and tapped on the lower side for ¾-inch screws, and a clamp was attached in the same manner as a center-rest clamp. With the plate set in the position shown in the illustration, a hole for the 4-inch boring-bar was bored and finished so that the bar would be a running fit in the hole, a pair of small angle-plates mounted on the carriage being used to steady the plate during this operation. The plate was then removed and drilled for the two 20-tooth reducing gear shafts. A special live center was then made, which was long enough to extend out through the faceplate, a distance equal to the thickness of the driving gear *B*, plus the length of the tapered portion of the center. The driving gear *B* was doweled to, and driven by the faceplate. A 120-tooth gear was fitted and keyed to the boring-bar as shown, and was driven by two 20-tooth pinions carried by short jack-shafts, extending through the plate. The two 70-tooth gears on the opposite end of these jack-shafts, between the faceplate and the gear plate, mesh with the 70-tooth driver. It will thus be seen that the lathe spindle makes six revolutions to one of the boring-bar, and that with the lead-screw geared for cutting one thread per inch, the carriage would advance 6 inches to every revolution of the boring-bar.

The 120-tooth gear on the boring-bar was divided into four equal parts, so that after finishing one thread and removing the two driving pinions, the beginning of the second thread could be properly located by turning the bar 90 degrees, or one 30-tooth division of the gear, and replacing the pinions. This operation would be repeated when locating the third and fourth threads. The finishing tool, which of course was made to a standard Acme thread gage, had to be removed and reset after each cut, the proper setting being obtained by measuring from the cutting edge of the tool to the opposite side of the bar with a micrometer. The diameter of the bar was 4 inches, and the measurement from the cutting edge of the tool to the opposite side of the boring-bar, 5 inches, the outside diameter of the thread being 6 inches.

Fullerton, Pa. EDWIN J. BACHMAN




Attachment for cutting a 6-inch Lead Thread on a 1-inch Lead Capacity Lathe

## CALCULATING GEOMETRICAL PROGRESSION

The following method of determining numbers in geometrical progression by means of a slide-rule, or common scale, is simple and enables the required numbers to be determined more rapidly than by the use of factor tables or any of the other methods commonly employed. This method should be of considerable assistance to designers who wish to calculate a range of speeds for a lathe or drilling machine, and for other work of a similar nature.

To illustrate the principle involved, place a common rule along the bottom scale of, say, a 10-inch slide-rule; it will be found that from 1 to 10 on the slide-rule scale measures approximately 10 inches. Now allowing for the slight difference between the length of the 10-inch slide-rule scale, and the 10-inch length measured on the common rule, we have at each inch mark, beginning at zero on the common scale, eleven numbers on the slide-rule from 1 to 10 inclusive, which are in geometrical progression. Approximately opposite the first or zero mark of the common rule will, of course, be found 1 on the slide-rule scale. The next number which is in geometrical progression will be found on the slide-rule scale approximately opposite 2 on the common scale. By inspection, we find this to be approximately 1.24. It is now evident that the eleven numbers which are in geometrical progression will be found on the slide-rule scale opposite each inch mark of the common scale. These numbers will be found to be approximately 1, 1.24, 1.55, 1.97, 2.48, 3.14, 3.96, 5, 6.3, 7.9, and 10. The numbers thus determined are, of course, only approximately correct, as the difference between the length of the two scales makes it impossible to obtain accurate results in the manner described. This example is given simply to illustrate the principle on which the method is based.

The following

example, which shows the practical application of this method, should enable anyone to apply it. Suppose that in designing a lathe it is desired to give the spindle twenty-four changes of speed, ranging from 5 to 250 revolutions per minute. If a 10-inch slide-rule is used, the procedure is as follows: First, determine the distance on the slide-rule in inches from 5 to 250. As the rule is graduated from 1 to 10, first measure from 5 to 10. This measurement is found to be 2 31/32 inches. Next measure from 10 to 100, or the whole length of the slide-rule scale. This is 9 27/32 inches. Finally, measure from 100 to 250, which is 3 29/32 inches. Now by adding the measurements thus obtained, we have the total measurement from 5 to 250, which is 2 31/32 + 9 27/32 + 3 29/32 = 16 23/32 or 16.71875 inches. Since we start at zero on the common scale we divide, not by the number of speeds required, but by 1 less than that number, or 23. 16.71875 ÷ 23 = 0.727 inch. This is a little over 23/32 inch from number to number. We now proceed to find the required speeds. Beginning at 5 on the slide-rule, measure 0.727 inch to the next number, which is found to be 5.9, the next is 7.0, then 8.3, and then 9.85. Now go back to 10 and proceed to measure as before, allowing for a remainder of 0.15, which is the difference between 9.85 and 10; we obtain 11.6, 13.8, 16.4, 19.5, 23.1, 27.4, 32.4, 38.4, 45.5, 54, 64, 76, 90, 106, 126, 150, 178, 210, and 250. These twenty-four speeds are in the correct geometrical progression with a ratio of approximately 1.18. It is sometimes more convenient to set a pair of dividers to the measurement, especially when it is an odd number like 0.727, which was used in the example considered. The writer has found this method to be very rapid and a great time-saver over other methods.

Baltimore, Md. W. C. STEUART

## STOPS FOR LATHE AND SCREW MACHINE SPRING CHUCKS

Turning or facing work to length when exact measurements are required on duplicate parts is a difficult matter when an ordinary spring chuck is used unless some accurate means are provided for stopping the work in exactly the same place irrespective of the chuck. A little difference in the diameter of the piece or a little different tension used in pulling back the chuck will draw the chuck back into its holder more or less, as the case may be.

Two methods of handling work of an accurate nature adaptable to screw machines and lathes are shown in the accompanying illustrations. At *A*, Fig. 1, is shown a nose-piece such as may be screwed to the nose of either an engine lathe or a screw machine, adapting it to the use of a draw-back spring collet such as shown at *B*. This nose-piece is especially constructed and has three splines equally spaced,

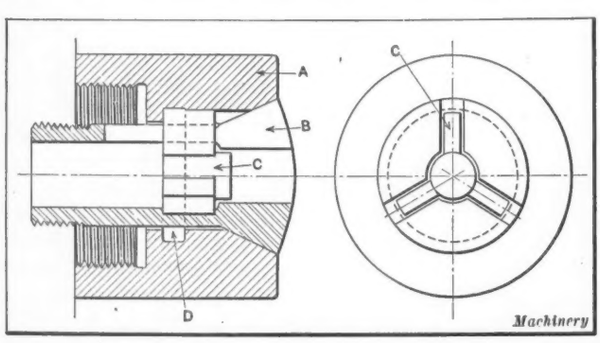



Fig. 1. Spring Chuck provided with an Accurate Stop

cut back into the clearance groove *D*. Into these splines and back against a shoulder, as shown, is pressed the spider *C* which acts as the stop for the work. In order to assemble the parts, the slots which are usually cut into the spring collet have to be made wider than usual so as to allow the arms of the spider to pass through them. In assembling,

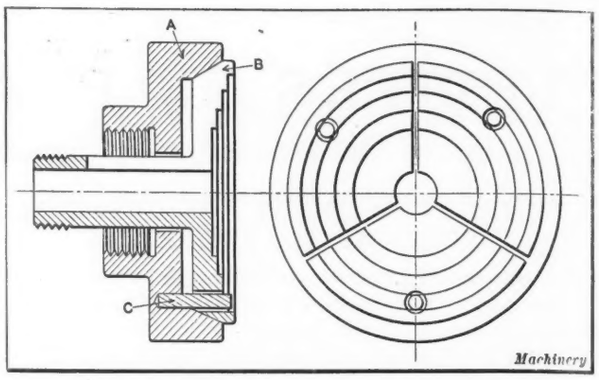



Fig. 2. Step Chuck with Stop, for Use in turning Disks

the collet is first put in place inside the nose-piece *A* and then the spider is pressed in until it is seated in the nose-piece. This is an excellent arrangement for this type of collet, where the work is short enough to permit of its use.

In Fig. 2 is shown the method used in handling disks and work of a similar nature in a bench or engine lathe step chuck. The regular nose-piece used in connection with step chucks is shown at *A*, while *B* shows the step chuck. These chucks are made of cast iron, split into three equal parts so that they will readily spring together or open as required. The chucks are turned to various diameters or steps as shown, according to the requirements. As the operation of the chuck causes the split jaws to spring unevenly, it is necessary, when close work is required and when it is desired to keep the tools set up for repetition work, to provide pins like that shown at *C*. These pins are driven into the nose-piece, and pass through clearance holes in the chuck, forming a seat for the work to rest against. After these pins are driven into place, they are turned or ground off to the required length while in place. As the chuck is tightened it naturally draws back into its seat, drawing the work back with it and thus seating the work firmly on the pins.

New York City DONALD A. BAKER

## COMBINATION DIE

For perforating, cutting off, and bending the No. 16 gage hot-rolled steel stamping shown in Fig. 1, a special punch and die was made, the construction of which is shown in Fig. 2. It is obvious that a job of this kind would ordinarily require two or three separate operations, and would employ as many presses at a time, or the same press for each separate operation. As a time-saver, therefore, the description of this special punch and die should be of interest.

The punch-shoe *A*, Fig. 2, is made of cast steel, and is secured to the ram of the press by means of the shank *S*. As will be noted, the punch-shoe carries the punches *C*, the arrangement and shape of which will be apparent by referring to the lower view in Fig. 3. This view is a plan of the perforating end of the die, showing the hardened tool steel blocks *D* and $D_1$ and the hardened tool steel bushings *E*. These tool steel parts—sections *D* and $D_1$ and the three bushings, as well as the tool steel forming die *X*, Fig. 2—are set into the die-shoe *B*, which is made of machine steel and suitably secured thereto. Fig. 2 shows the arrangement and method of fastening. There are seven round punches, three square punches and two triangular cutting punches carried in shoe *A*. The punches are all made of hardened tool steel, and are ground to size and securely fastened in place. The triangular punches are fastened by means of the tapered pins *F*, while ordinary headless set-screws are employed for the other punches. The bending punch *G* is fastened to the shoe, as shown, being located in a dovetail slot.

By referring again to the lower view in Fig. 3, it will be seen that the die section *D* contains five perforating holes, an arrangement which is much better than using separate bushings for each hole, on account of the proximity of the holes to the edges of the work and to each other. The section

$D_1$ contains, in addition to the plain hole and the two triangular openings, an inserted bushing for the larger hole, there being in this case sufficient room for the use of a bushing. For the same reason, that is, since there is sufficient space, the bushings *E* are also seated independently. The steel stripper *K*, Fig. 2, is held in place by means of cap-screws, which also fasten the guides *H*, Fig. 3, and incidentally the die-plates *D* and $D_1$ to the die-shoe *B*.

The gage, or stop, *J* is made of hardened tool steel, so that it will withstand wear, and has a gaging point or ridge *L*, which is shown in Fig. 2 in the partial plan view of the stop *J*. This provision is made in order to permit the work to be adjusted angularly in the die when the stock runs slightly narrow, and at the same time to maintain a gaging point at the center line of the work; if the gage point *L* were not provided, this would not be possible, for the work would then be stopped at one of its corners.

The upper view of Fig. 3 shows the work after being perforated and notched, preparatory to being advanced to the bending die and to being cut off at *Z* and bent. After the work has advanced to the position shown in Fig. 2, just before it is bent, the cutting-off blade *M* operates at the beginning of the downward stroke of the press ram. The partial sectional view through the cutting-off blade illustrates the method of operation. As the punch descends, the cam

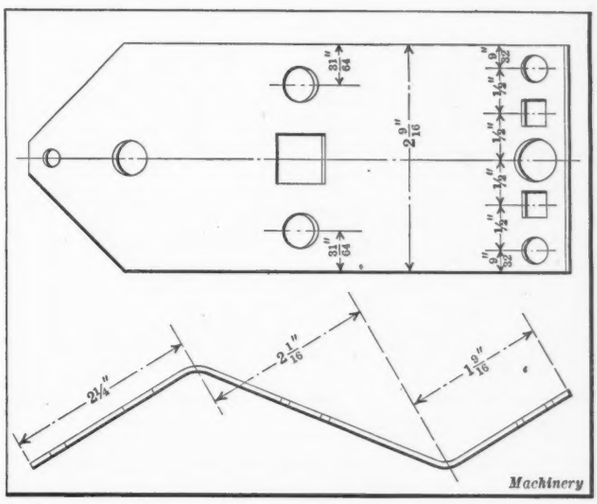



Fig. 1. No. 16 Gage Steel Stamping, which is perforated, cut off, and bent in One Operation

*R*, until it severs the work against the cutter blade *T* which is made of tool steel, hardened and ground, and is set into the stripper plate *K*. As soon as this operation is completed,

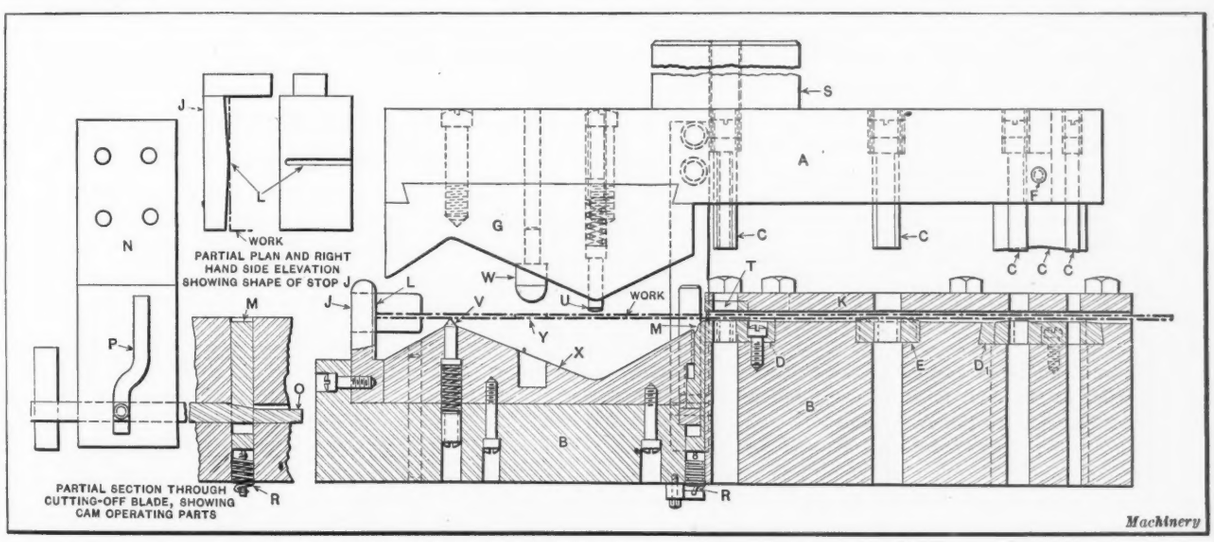



Fig. 2. Combination Punch and Die employed in making the Piece shown in Fig. 1

*N*, which is attached to it, moves the horizontal cam *O* by means of a roller which engages the slot *P*, in the direction indicated by the offset in the slot. This movement of *O* forces the cutter *M* to ascend against the tension of spring

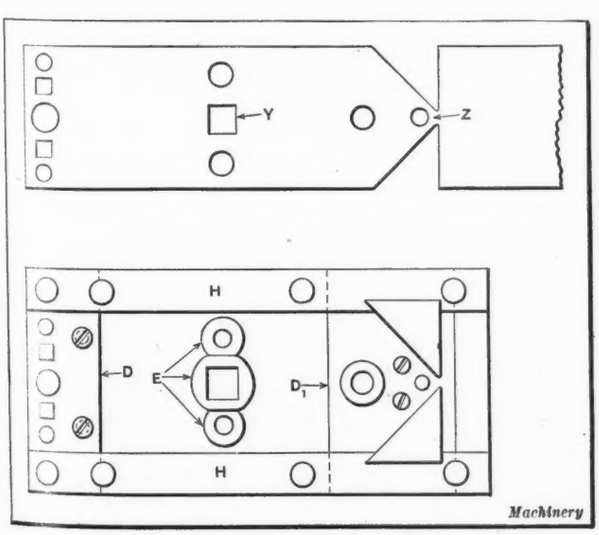



Fig. 3. Plan View of the Perforating End of the Die and Appearance of Work before cutting off and bending

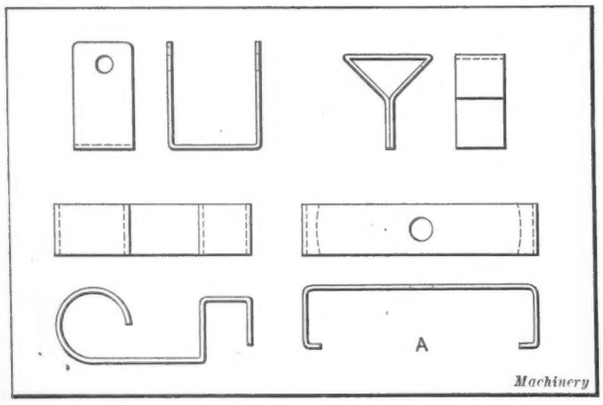
the cutter *M* is returned to the position shown in the illustration through the action of spring *R*. As the punch descends and while the cutting-off operation is taking place, the spring-seated plunger pins *U* and *V* come into contact with the work and prevent shifting or slipping during the shearing operation, so that the square-end pilot *W* may enter the hole *Y* in the piece, and hold the stamping more securely.

This punch and die produces uniform stampings in quantity. In comparison with former dies employed in making this piece, it is also much more efficient and entirely satisfactory, having produced 12,000 complete stampings in a day, while it was possible formerly to obtain but 6000 pieces per operation daily.

Highland Park, Mich. E. A. WALTERS

## PUNCH PRESS WORK IN A STANDARD WIRE FORMING MACHINE

The shaping of sheet metal on a standard wire forming machine of either the four- or six-slide type is an interesting operation, although one which is seldom employed. Many flat metal articles, similar to those shown in the accompanying illustration, can be more easily handled in this manner than on the punch press. The sheet metal is fed with the edge up, and guides and a cut-off are made to accommodate the width and thickness of the metal. The feed must also




Flat Metal Parts formed on Wire Forming Machine

be properly adjusted; this can be done in various ways, according to the type of feed with which the machine is equipped. Straightening rolls are not usually necessary unless the metal is very uneven, but if used, they should have a plain broad face somewhat wider than the width of the metal. These few changes are all that are usually required to adapt a wire bending machine to sheet metal work.

Tools must be made for different sheet metal forming operations, of course, the same as when using the machine for wire forming. Herein lies room for much originality and the application of many clever ideas. For instance, in the fruit jar clamp shown in the accompanying illustration at *A*, the hole in the top of the clamp that fits over the knob in the glass jar top is punched by the slide that ordinarily does the binding. In this case, the cam that actuates the slide is adjusted so that it will operate after the front forming slide has functioned. The metal is thus bound tightly between the front forming tool and the center toolpost before being punched. A round punch is carried by the binding slide, and the die is located in the center toolpost. The actual forming of the metal is carried on in the same manner as if it were wire. The ends are formed to fit the bottle as shown, one end being curved at the cutting-off operation, and the other at the final forming operation by means of a cutting tool attached to the rear slide.

In a similar way many different shapes may be formed from flat metal and holes punched simultaneously. Less expensive and complicated tools are required than would be the case on a punch press, and the upkeep of the machine is also less; in addition, the rate of production is usually a little faster than with the punch press.

Baltimore, Md. S. B. Royal

## COMPARISON OF U. S. STANDARD AND WHITWORTH SCREW THREADS

The difference in form that exists between the Whitworth and the U. S. standard screw thread is graphically shown in the accompanying diagram. The comparison is based upon a screw with 1 thread per inch. Clearances and interferences for the two forms of threads having any other pitch may therefore be obtained by dividing the respective values given in the diagram, by the number of threads per inch under consideration.

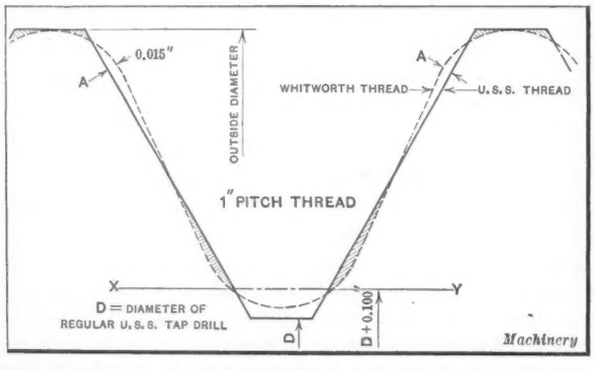



Diagram showing graphically the Comparison between U. S. Standard and Whitworth Screw Threads

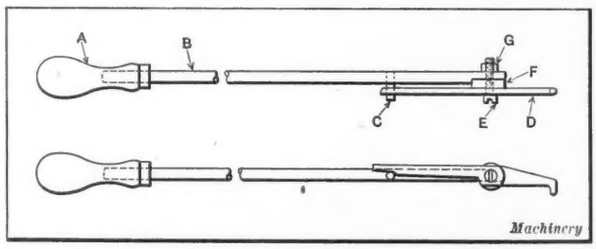
In order to fit a U. S. standard screw into a Whitworth tapped hole or nut, round the outside corners of the screw and change the outline of the thread below the pitch line by slightly filing the flanks. These changes are indicated in the diagram by the sectioned areas. If it is desired to fit a Whitworth screw into a U. S. standard tapped hole or nut, drill out the hole or nut, using a drill which is larger than the tap drill required for an equal size U. S. standard tap, as shown by the line *XY* in the diagram. For 1 thread per inch, this increase in diameter of the tap drill will be 0.100 inch, and for other numbers of threads, the amount of increase will be found by dividing 0.100 inch by the number of threads per inch. Thus, for 10 threads per inch, $0.100 \div 10 = 0.010$ inch. The flanks of the Whitworth thread above the pitch line are then filed slightly as indicated at *A* in the illustration.

To those who have occasion to make repairs on English machinery in this country or on American machinery in England, this comparison should be of particular interest. It should be noted, however, that the methods mentioned are recommended only for fastening screws and ordinary threaded parts, and should not be employed where accurate threads are required.

Springfield, Mass. G. R. Richards

## TOOL FOR DETERMINING QUENCHING TEMPERATURE OF STEEL

The tool shown in the accompanying illustration for testing the correct temperature at which to quench all water-hardened carbon steels, to get the best results, should be




Tool for ascertaining the Critical Point of Steel

of interest. The design of the tool is based upon the principle that when the critical point, or correct quenching temperature for hardening is reached in carbon steels, they are not attracted by a magnet.

Referring to the illustration, *A* is an ordinary wooden file handle, *B* is a brass rod about 3/16 inch in diameter and of the proper length to suit the furnace. The brass stop-pin *C* is a rest for the hardened, magnetized "tip-up" *D*. Part *D* should be about 3 or 4 inches long, and should turn freely on the brass screw *E*, and be sufficiently heavier on the tail end than on the point, so that it will return to the stop-pin by means of its own weight when disturbed. *F* is a brass washer and *G* a check-nut for screw *E*. In use, the point of the "tip-up" is placed upon the piece that is being heated for hardening in the furnace, when it is thought that the correct temperature for quenching is being approached. The "tip-up" should be watched carefully when raising the tool from the piece for if the work is not hot enough, the tail of the "tip-up" will rise because of magnetic attraction, but if the temperature is correct, the tail will not be deflected, as the steel at the decalescence temperature will have no attraction for the magnetized point. Care should be taken, however, to prevent the "tip-up" from becoming heated sufficiently to draw its temper and lose its magnetism. This device has one advantage over a pyrometer on general work, in that it is unnecessary to know the characteristics of the

steel or the percentage of carbon which it contains, in order to obtain good hardening results, as irrespective of carbon percentage, this simple device will unfailingly indicate the critical point. All parts except the "tip-up" should be made of brass, since brass will not attract the magnetized "tip-up" and consequently will not cause the tail to drag, as would be the case if steel were used.

Wethersfield, Conn. R. G. TERRY

## DRAWING A TAPERED STEEL SHELL

Difficulty is usually experienced in drawing tapered steel shells such as shown at *A* in Fig. 1. In drawing this particular shell, five sets of tools were required, the first of which is the combination blanking and forming die shown in Fig. 1. The material of which these shells are made is No. 20 U. S. gage steel plate stock, 0.0375 inch thick, the blank being 5 13/16 inches in diameter and drawn, in the first operation, to the shape shown at *B*. The details of the punch and die are clearly shown in the illustration and the construction and operation should need no detailed explanation. It will be noted that the familiar rubber block construction is employed as a buffer for the drawing ring.

The second operation is shown in Fig. 2 at *A*, which is the first step in forming the taper of the shell. It will be noticed that all the straight part of the shell is not drawn in and that a flange is left for subsequent locating purposes. This flange is cut off in a later operation. The die has a rubber buffer similar to that shown in Fig. 1, the attachment screw and also the drawing pins being shown. The outside diameter of the drawing ring *B* is made the same as the inside diameter of the shell formed in the first operation, or 3 inches. The shell is thus positively located on the ring and its shape maintained while the drawing is taking place over the corner of the ring at *C*. Drawing the shell when held in this manner, prevents it from being upset and also keeps the metal normal. It will be noted that a part of the shell

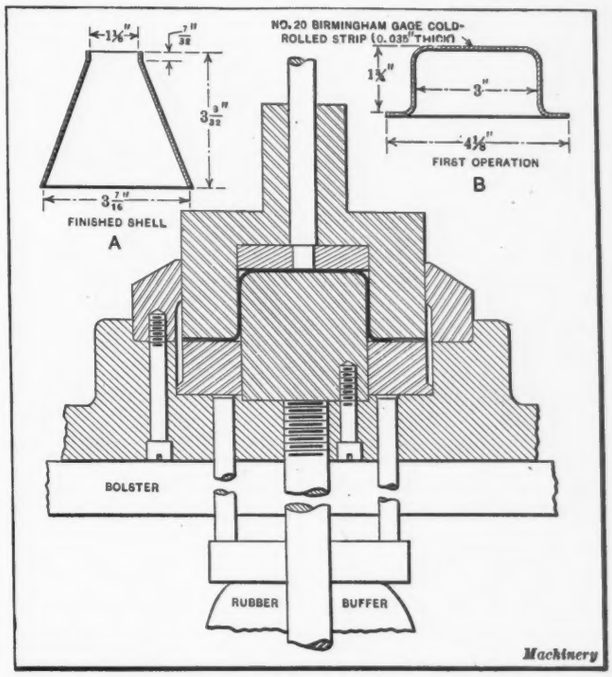



Fig. 1. Combination Blanking and Forming Die used in the First Drawing Operation

at the top is also drawn straight so as to insure greater concentricity. The center part of this die *D* is a pressed fit in the die-holder.

The third drawing operation is performed in the die shown at *B* and consists of stretching the taper on the shell. The flange of the shell is held firmly between the drawing ring *E* and the punch *F*, the drawing ring being supported by rubber buffers which are adjusted sufficiently to hold the shell. The same rubber supports as used on the previous dies may also be used on this die. The drawing ring *E* is raised sufficiently by the rubber so that when the shell is placed on the die it locates itself on the cone *G*, while the flange rests on the drawing ring. The trimming and edging die for finishing the large or open end of the shell is shown at *C*. The drawing ring *H* is spring-supported, being used merely to strip the finished work from the die after the flange has been trimmed. In this punch, as well as in the previous punches, it will be noticed that a knock-out rod is provided for ejecting the shells when they become lodged in the punch. The final operation is performed in a die known as a hole and flange die, shown at *D*. Its construction is quite simple and should require little explanation. Ring *J* locates the work while the hole is being punched and the small end formed, and by means of its spring support it also ejects the work after the operation.

Toledo, Ohio J. BINGHAM

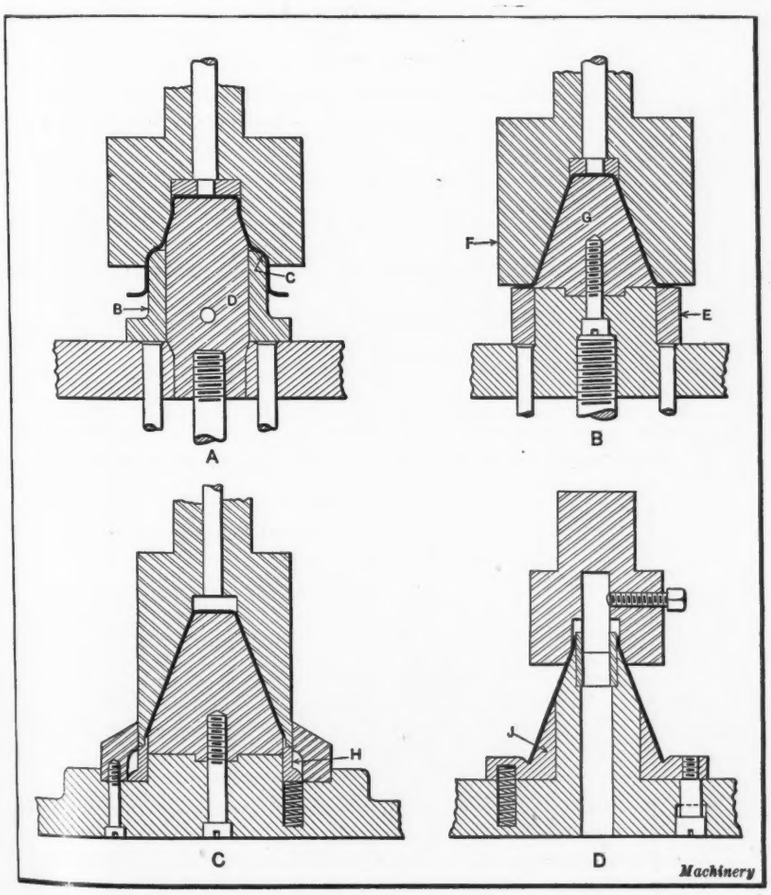



Fig. 2. Construction of the Four Dies employed for completing the Shell

* * *

## EXTENT OF MOVING PICTURE INDUSTRY

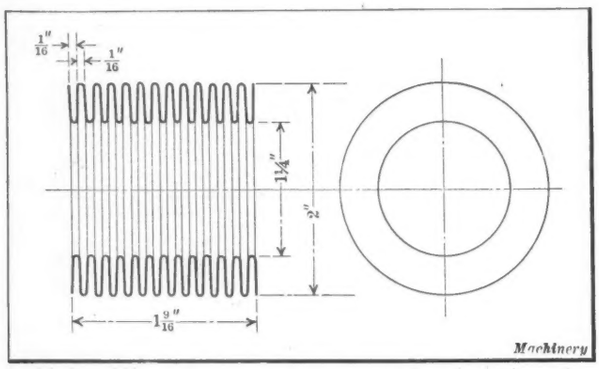
The extent of the moving picture industry in the United States may be judged from the fact that about 300,000 kilowatt-hours of electric current are used daily merely for moving picture machines. The investment in the machine industry alone, devoted to moving picture machines, has been estimated at $11,000,000. Probably 5000 machines are worn out annually, and the total amount of money absorbed by the industry may be estimated at about $500,000,000 a year.

# HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

## FORMING DEEP CORRUGATIONS

H. A. A.—Corrugated parts similar to the one shown in the accompanying illustration are required in large quanti-




Corrugated Copper Parts required to be produced in Large Quantities

ties. How can they be produced? Copper having a thickness of about 1/64 inch is to be used.

This manufacturing problem is submitted to the readers of MACHINERY.

## SIZES OF TAPER PINS FOR SHAFTS

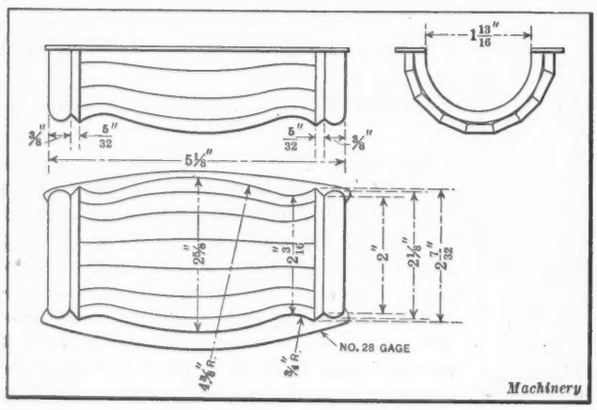
C. H. G.—The writer would like to obtain from the readers of MACHINERY any available information relating to sizes of taper pins required for different sizes of shafts. This is a matter that could be calculated, of course, but what is wanted in this case is some tabulated information giving the shaft diameters and corresponding taper pin sizes employed in good practice.

## CAST IRON OR BRONZE FOR BEARINGS

Machine Tool Builder—The opinions of men in the machine tool trade are invited as to the relative merits of cast iron and bronze bearings for machine tools when the spindles are made of steel, hardened and ground.

## DRAWING AN ODD SHAPE

M. G.—The accompanying illustration shows a piece of drawing that is to be performed in three operations; the first operation presumably draws the part into a half-round shape; the second operation dents the shape, producing the lines indicated; while the third operation bends the part longitudinally to the shape indicated. Can any reader of MACHINERY, who has performed these or similar operations on metal of the same weight and size, furnish descriptions and drawings of the actual tools and dies employed?




Piece to be drawn in Three Operations

## FINDING ANGLES OF SPECIAL SCREW THREADS

A. B.—The illustration shows a section of a screw thread; please show how to find the angles $m$ and $n$.

Answered by Elmer Latshaw, West Philadelphia, Pa.

The method of finding the angles of a special screw thread can be applied to the problem which appeared on page 256 of the November number of MACHINERY, and can also be used in special cases in which the top and bottom radii of the screw thread are unequal. Draw $OA$ and $OB$ parallel to the sides of the thread. Then $AP = R + r$; also $BQ = R + r$. Further, $\frac{a}{h} = \tan x$. $\frac{AP}{OP} = (R + r) \div \left(\frac{h}{\cos x}\right) = \frac{(R + r) \times \cos x}{h} = \sin z$; and $x - z = m$.

The required angle $n$ is obtained by a similar method. In this case $\frac{b}{h} = \tan y$; and $\frac{BQ}{OQ} = (R + r) \div \left(\frac{h}{\cos y}\right) = \frac{(R + r) \times \cos y}{h} = \sin w$. Then $y - w = n$.

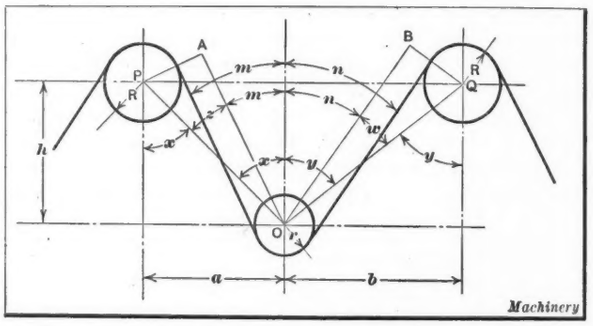



Diagram showing Method of finding Angles of Special Screw Thread

*Example*—Let $a = 0.25$; $b = 0.375$; $h = 0.3125$; $R = 0.05$; $r = 0.04$. Then $\tan x = \frac{a}{h} = \frac{0.25}{0.3125} = 0.80000$; hence $x =$ 38 degrees 39 minutes 35 seconds.

$\text{Sin } z = \frac{AP}{OP} = \frac{(R + r) \times \cos x}{h} = \frac{0.09 \times 0.78087}{0.3125} =$ 0.22489; hence $z = 12$ degrees 59 minutes 47 seconds.

Then $m = x - z = 38$ degrees 39 minutes 35 seconds $-$ 12 degrees 59 minutes 47 seconds $=$ 25 degrees 39 minutes 48 seconds.

$\text{Tan } y = \frac{b}{h} = \frac{0.375}{0.3125} = 1.20000$; hence $y =$ 50 degrees 11 minutes 40 seconds.

$\text{Sin } w = \frac{(R + r) \cos y}{h} = \frac{0.09 \times 0.64018}{0.3125} = 0.18437$; hence $w =$ 10 degrees 37 minutes 28 seconds.

Then $n = y - w =$ 50 degrees 11 minutes 40 seconds $-$ 10 degrees 37 minutes 28 seconds $=$ 39 degrees 34 minutes 12 seconds.

* * *

Outside of Germany and Austria-Hungary, the shipyards of the whole world during 1918 produced 5,477,444 gross tons of merchant shipping. This is 63 per cent higher than the total in 1913, which was the former record, and included the output of Germany and Austria.

# NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY


**"Ohio" Tilted Rotary Milling Machine.** Oesterlein Machine Co., Cincinnati, Ohio ..... 979
**Beaman & Smith Continuous Milling Machine.** Beaman & Smith Co., Providence, R. I. ..... 983
**Reeves Roll Grinder.** Gardner Machine Co., Beloit, Wis. ..... 983
**Knight Milling and Drilling Machine.** W. B. Knight Machinery Co., St. Louis, Mo. ..... 985
**Keller Universal Cutter and Tool Grinder.** Keller Mechanical Engraving Co., Brooklyn, N. Y. ..... 986
**"Abitz" Reversible Countershaft.** Rockford Metal Specialty Co., 720 S. Main St., Rockford, Ill. ..... 986
**Nelson Universal Angle Fixture.** Nelson Tool & Machine Co., 253 Norfolk St., Newark, N. J. ..... 987
**Nilson Turnbuckle.** Nilson Die & Tool Co., 319-331 W. Ohio St., Chicago, Ill. ..... 987
**Cincinnati High-power Milling Machine.** Cincinnati Milling Machine Co., Cincinnati, Ohio ..... 988
**Stow Portable Electric Drill.** Stow Mfg. Co., Binghamton, N. Y. ..... 990
**Hjorth Submerged Drilling Attachment.** Hjorth Lathe & Tool Co., 27 School St., Boston, Mass. ..... 990
**Hercules Power Press Broach.** Hercules Machinery Co., Union Trust Bldg., Detroit, Mich. ..... 991
**Improvement in Taft-Peirce Toolmaker's Knee.** Taft-Peirce Mfg. Co., Woonsocket, R. I. ..... 991
**Eccentric Boring Chuck.** W. F. Meyers Co., Bedford, Ind. ..... 991
**Oliver Profiling Machine.** Oliver Instrument Co., Adrian, Mich. ..... 992
**Thompson Universal Cutter Grinding Attachment.** Thompson Grinder Co., Springfield, Ohio ..... 992
**Landis Threading Die-head.** Landis Machine Co., Inc., Waynesboro, Pa. ..... 993
**Bridgeport Combination Grinding Machines.** Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn. ..... 993
**Taylor & Fenn Vertical Milling Machine.** Taylor & Fenn Co., Hartford, Conn. ..... 994
**Manhattan Universal Casting Grinder.** Manhattan Machine & Tool Works, 42-50 Market Ave., N. W., Grand Rapids, Mich. ..... 995
**"Stamco" Heavy-duty Planer.** Streine Tool & Mfg. Co., New Bremen, Ohio ..... 995
**"Milford" Power Hacksaw Machine.** Henry G. Thompson & Son Co., Chapel and Mill Sts., New Haven, Conn. ..... 996
**"Sterling" Foot-power Lathe.** Shepard Lathe Co., Canal and Jackson Sts., Cincinnati, Ohio ..... 996
**"Logan" Air-operated Collets.** Logansport Machine Co., Logansport, Ind. ..... 996
**Cylinder Boring Attachment for South Bend Lathes.** South Bend Lathe Works, 420 E. Madison St., South Bend, Ind. ..... 997
**Brandt Indexing Fixture.** Brandt & Carpenter, 189 Main St., New Britain, Conn. ..... 997
**Hawes End Surface Grinding Machine.** C. L. Hawes, 12 Adams St., Ashtabula, Ohio ..... 998
**Newton Heavy-duty Vertical Milling Machine.** Newton Machine Tool Works, Inc., Philadelphia, Pa. ..... 998
**Grand Rapids Casting Grinder.** Grand Rapids Grinding Machine Co., 29 Ottawa Ave., N. W., Grand Rapids, Mich. ..... 999
**"Zeus" Arc Welding Machine.** Gibb Instrument Co., 1644 Woodward Ave., Detroit, Mich. ..... 999
**Kane & Roach Bending and Straightening Machines.** Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y. ..... 1000
**Simplex Sine Bar.** Simplex Tool Co., Woonsocket, R. I. ..... 1001
**Thompson Tool and Cutter Grinder.** Thompson Grinder Co., Springfield, Ohio. ..... 1001
**Defiance Rail Drilling Machine.** Defiance Machine Works, Defiance, Ohio ..... 1001
**"Safshift" Belt Shifter.** Artisan Mfg. Co., Lockland, Ohio. ..... 1002
**American Air-operated Chucks.** American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill. ..... 1003
**Western Universal Radial Drilling Machine.** Western Machine Tool Works, Holland, Mich. ..... 1003


## "Ohio" Tilted Rotary Milling Machine

A CASUAL inspection of the illustrations of the "Ohio" tilted rotary milling machine, which has recently been placed on the market by the Oesterlein Machine Co., Cincinnati, Ohio, will suffice to show that the designers have departed from established practice in milling machine design. This is

*The design of this machine represents a noteworthy departure from standard practice. Provision is made for employing either the continuous rotary method of milling, or for applying an indexing principle of operation by which successive pieces of work are brought opposite the cutter, after which the ram that carries the spindle is advanced radially to feed the cutter across the work. By inclining the table at an angle of 15 degrees, a better opportunity is afforded for the coolant to wash away chips. This inclined table also makes it possible to use an auxiliary reservoir in which the cutters and work can be submerged in a bath of coolant while the milling operation is performed. The term "sub-surface" milling has been applied to this method of cooling the milling cutters and work.*

a production miller; and as such, it is of vital importance to provide for attaining high rates of output in addition to securing work of the required accuracy and perfection of finish. In order to allow the successive operations to be as nearly continuous as possible —or in other words to reduce the idle time of the machine

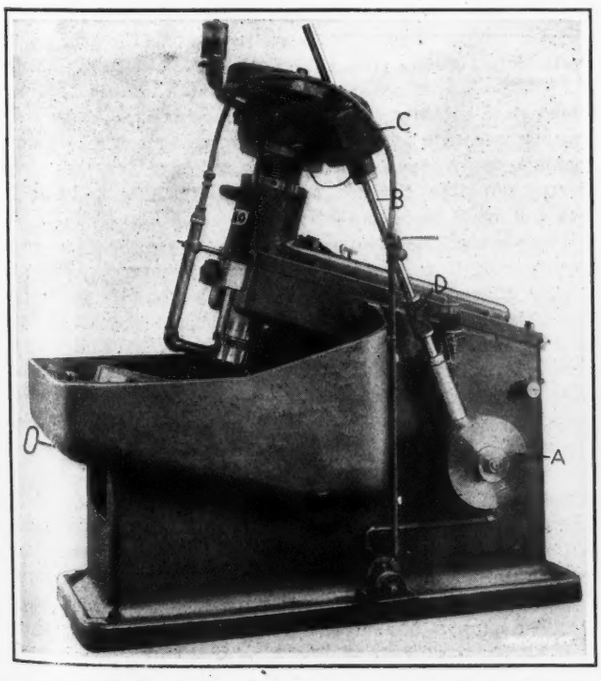



Fig. 1. Oesterlein Machine Co.'s "Ohio" Tilted Rotary Milling Machine

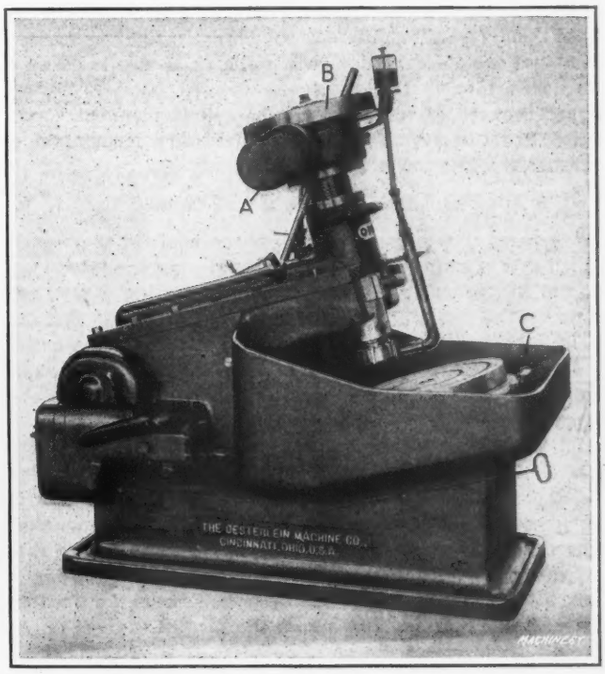



Fig. 2. Opposite Side of the "Ohio" Tilted Rotary Milling Machine

between successive operations—the rotary principle of milling has been adopted. But the designers have gone a step further: In addition to allowing the machine to be used as a continuous rotary miller, provision is also made for using it as an indexing machine. When operated in this way, from two to seventy-two work-holding fixtures may be set up on the table, and the indexing will proceed in such a way that successive pieces of work are brought into the milling position. It will be seen that the vertical milling spindle is mounted on a ram of somewhat the same form as that used on a shaper, and when the "Ohio" tilted rotary milling machine is used as an indexing miller, a cam mechanism imparts a reciprocating movement to the ram, so that the cutter is fed radially across the work and then backed away to allow the indexing of the table to bring the next piece of work into the operating position. In this way, neither the machine nor its operator is idle for any appreciable length of time; and as a result, high rates of production are attained.

The machine is driven by a single pulley *A*, shown in Fig. 1, from which power is transmitted through bevel gears and the driving shaft *B* to a pair of bevel gears contained in case *C;* and thence through a geared drive to the spindle. It is desirable to provide for rotating the spindle either right-hand or left-hand, and such provision has been made on the present machine by means of a knurled coupling *D*, which may be released to enable shaft *B* to be adjusted in such a way that the driver in case *C* will mesh at the opposite side of the driven bevel gear, thus effecting the desired reversal in the direction of rotation. Evidently, it will be required to obtain changes in spindle speed according to the size of the cutter that is used, and other conditions of operation. Such changes of speed are effected by means of gears contained in a case which is best shown at *A* in Fig. 2. In this case, there are change-gears mounted on fixed centers, and different combinations of gears may be furnished to give thirty different changes of speed. A flywheel *B* is mounted at the top of the cutter-spindle to afford necessary momentum to equalize the rotation of the cutter.

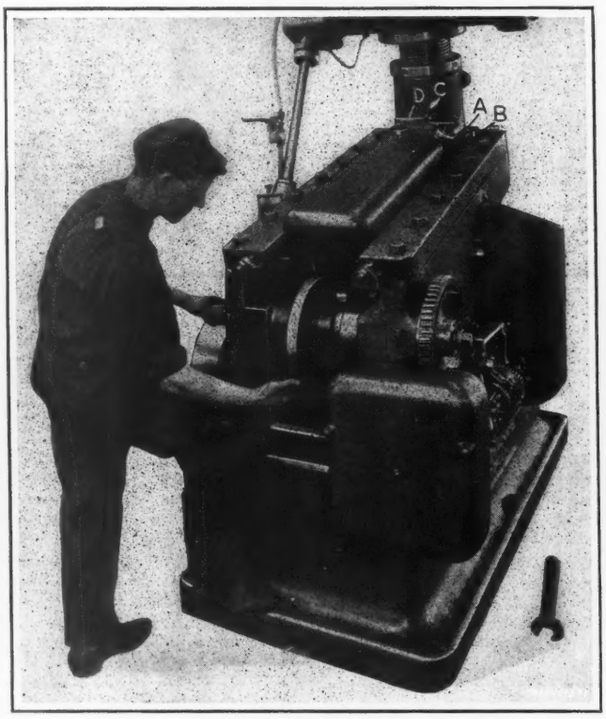



Fig. 3. Rear View of "Ohio" Tilted Rotary Milling Machine showing Method of changing Feed-cam

### Radial Feed for the Milling Cutter

A general statement has already been made of the way in which this machine may be used by indexing the table from station to station and imparting a reciprocating radial feed movement to the milling cutter during each period that the table is held stationary. This feed movement for the cutter is secured from pulley *A*, Fig. 1, by means of a cross-shaft which runs through to the opposite side of the machine and imparts power to the mechanism best shown in Fig. 4. A bevel gear carried at the end of this cross-shaft meshes with gear *A*, from which power is transmitted through a clutch *B* and change-gears to a worm *C*, that drives the worm-wheel carried at the end of a shaft on which feed-cam *D* is mounted. This cam runs in contact with a roller secured to the ram on which the milling spindle is mounted, and by using a cam with the proper throw, provision is made for feeding the milling cutter radially across the face of the work. At the left-hand side of the machine there is a pull-rod which extends forward to the operating position, as shown in Fig. 2, and this rod provides for engaging the clutch shown at *B*, Fig. 4, the end of the pull-rod that manipulates the clutch yoke being shown at *E* in the latter illustration. The cam feeds the ram forward at a slow speed, during which time the cutting operation is performed, and then allows it to drop back rapidly at the end of the stroke. A four-gear feed-change mechanism regulates the rate of revolution of the cam when the miller is to be used as an indexing machine, or the rate of feed of the table when the miller is used as a continuous rotary machine. It will be apparent that in every case the rate of feed is established by change-gears, and different combinations may be obtained to secure any desired conditions of operation. The entire indexing mechanism and feed-cam may be omitted on a machine which is to be used entirely as a continuous rotary miller, and this mechanism may be added at any time to a machine which was not originally equipped in that way. It will be obvious that the change-gears regulate the rate of travel of the ram, and that the throw of the cam regulates the length of travel of the ram. A crank-operated shaft is provided, so that the feed mechanism may be operated by hand while setting up or trying out a job; and a lever is also provided for use in tripping the index mechanism.

### How Non-productive Time of Machine is Reduced

After the milling cutter has been fed radially inward to the required position on the work, the cam roller runs on to a section of the cam that is made of such a contour that it provides for quickly withdrawing the cutter to the starting point. A counterweight, carried by a chain secured to the ram, assures the maintenance of contact between the cam and its roller, and consequently the positive return of the milling cutter. By feeding the cutter radially over the surface of the work and indexing the table between cuts, loss of time between the milling of successive parts is avoided on those jobs which cannot be set up with adjacent pieces placed close together on the milling machine table. Another important feature is that non-productive time of the cutter approach is avoided because the cutter is set to travel the shortest possible distance before coming into engagement with the work to be milled.

Where a machine of this type is used for several different milling jobs, it will usually be found necessary to have a number of feed-cams that are adapted for handling the different classes of work. Provision is made for changing these cams as shown in Fig. 3. To make such an exchange, it is merely necessary to loosen the nut at one end of the camshaft and then withdraw the knurled plug at the opposite end of the shaft. In this way, the cam is released, so that it may be lifted out and a new cam substituted in its place. The camshaft is provided with keys that fit into keyways in the cam hub, to provide means of driving the cam; and a change of cams can be made with very little loss of time. While changing cams, it is evident that some means must be provided to hold up the ram which carries the cutter-spindle, in order to prevent it from running down the inclined ways when the support of the cam is removed. Such provision is made by means of a pin *A*, Fig. 3, secured in the ram, which comes into contact with a plug *B* that may be entered into

either of the holes furnished in the frame of the machine for that purpose.

### Features that Facilitate Setting up the Machine

When setting up for any milling operation that is to be performed by an intermittent or so-called indexing movement of the work-holding table, it is necessary to not only have a cam of the required throw, but also to regulate the relative position of the cutter and work so that the cutter will just fail to engage the work as it is indexed into the operating position, and will then be fed only a slight distance beyond the opposite extremity of the surface to be milled. If the cam were made to provide a considerable excess of feed movement for the cutter, it is evident that a corresponding loss of time would occur; but this careful regulation of the cam throw makes it necessary to obtain an accurate adjustment of the position of the cutter relative to the work, after the work-holding fixtures have been mounted on the table. Such adjustment is accomplished by means of a crank handle *C*, Fig. 3, that is furnished with a micrometer collar and provides for moving the position of the slide on which the cam roller is mounted, so that the cutter will be brought into the required relationship with the work.

### Provision for Rotating the Table

In Fig. 4, it will be seen that there is a universal joint *F* at the right-hand side of the illustration. Through this joint, power is transmitted to a horizontal shaft, and thence through bevel gears to a worm which drives a worm-wheel secured to the rotary table. On the worm-wheel which meshes with worm *C* in Fig. 4, there is a block *G* that controls the engagement and disengagement of the indexing mechanism for the table. It will, of course, be apparent that the radial feed movement of the cutter-slide and the indexing movement of the table must be synchronized in such a way that they occur alternately. The rotary movement of the table is accomplished by means of a worm 4 inches in diameter by 1¼ inch pitch, which meshes with a worm-wheel 28 inches in diameter. Evidently, this affords a lever arm of 14 inches for the power applied by the worm, and this mechanical advantage assures an ample driving force to carry the work past the cutter.

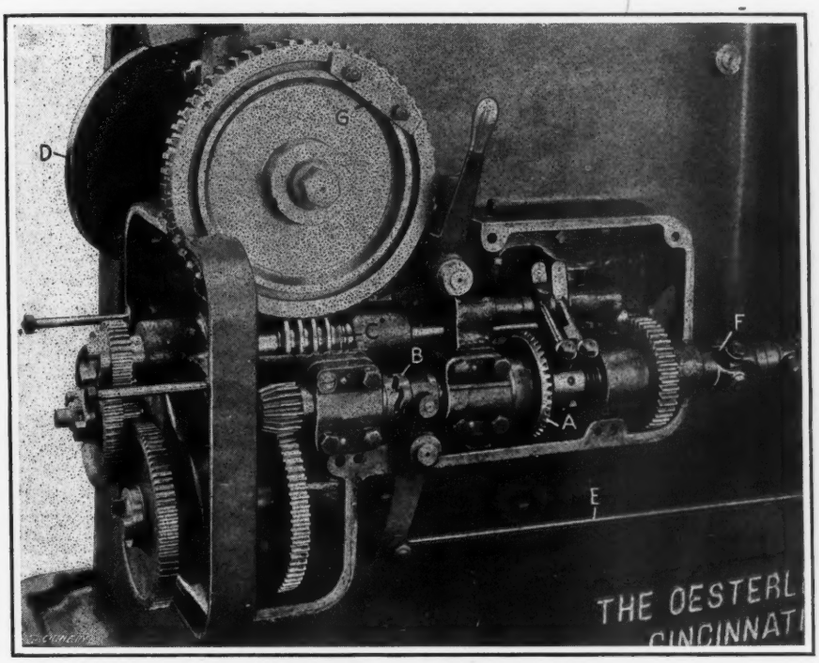



Fig. 4. Close View of Indexing and Feed Mechanism on "Ohio" Tilted Rotary Milling Machine

### Provision for Cooling the Cutters

To prevent an excessive temperature rise of the milling cutter and distortion of the work, a "Fulflo" pump is used, which has capacity for delivering thirty-five gallons of coolant per minute. The fluid is raised under pressure to a point several feet above the surface of the table, and then passes out of the delivery pipe into a pipe of larger diameter through which it descends to the cutter and work. This arrangement is clearly shown in Fig. 1. Evidently, the delivery of the fluid from a small pipe into one of larger diameter is the means of reducing its pressure, and as a result, a copious flow of coolant is delivered under conditions which preclude the likelihood of its spattering or impinging against the cutters and work so hard that it would rebound before having an opportunity to absorb the heat. The rotary table is inclined at an angle of 15 degrees, which results in locating the milling position in a pocket that affords protection against splashing the lubricant on the floor. With an arrangement of this kind, it is possible to utilize a more copious flow of coolant than would be possible if a horizontal table were used; and through the combination of an inclined table and a large volume of coolant flowing over the cutter and work, the washing away of the chips is greatly facilitated.

Reference to Fig. 5 will show that beneath the table there are two screened openings which allow the coolant to flow back into a reservoir in the base of the machine, which holds sixty gallons. The chips are held by the screens, and at the front of the bed, beneath the table, there is an opening through which the chips may be shoveled out into a truck. The tilting table also makes it possible to use an auxiliary pan that holds a sufficient volume of coolant to submerge the cutters and work while the milling operation is being performed. The depth of coolant in this reservoir is just sufficient to cover the tool and work on which it is engaged, but not deep enough to prevent the table from carrying the work above the surface of the fluid when it reaches the high side of the table. The term "sub-surface milling" has been applied to this method. An auxiliary pan for applying this principle of milling is not supplied as a regular part of the equipment, because the builders of the machine have not yet decided that this system possesses any important advantages over flooding the cutters and work with a constant stream of coolant supplied by a pump.

### Provision for Lubricating the Bearings

An effort has been made by the designers to provide means of lubricating the bearings, as far as possible, without requiring constant attention from the machine operator. A large sight-feed oiler has been placed on the speed-box to provide for lubricating the bearings in this box, and also the spindle bearings; and a similar oiler provides for lubricating the driving pulley shaft bearings. At the top of the ram there is another central point from which oil is distributed to the ram slide, this lubricator being shown at *D* in Fig. 3. It consists of a box with a hinged cover, and six holes in the bottom of the box. A quantity of oil may be poured into this reservoir, and it then flows through the holes into ducts that carry oil to the points where it is required. A similar lubricating device is provided for oiling the feed-box mechanism and for the rotary table bearings, the box provided on the table being shown at *C*, in Fig. 2.

### Structural Features of Design

Particular care has been taken to reduce the number of parts in this machine as far as possible, and to make all parts of liberal proportions so that they will withstand the

severe service which is required of a production machine. The body is cast in one piece, and both the rotary table and cutter-spindle are fully supported by this massive casting, which extends right out under the circular table and straight down to the floor beneath the table. No parts overhang in a way that is likely to cause strain or vibration, even the ram bearings being extended forward so that in the most advanced position, the ram is in full contact for its entire length. The worm-wheel which rotates or indexes the table is located as close to the under surface of the table as the taper bearing will permit. This worm-wheel is bolted and pinned to the table at the extreme end of the bearing, the central stud serving as a means of aligning the worm-wheel and table. The spindle has a No. 16 B. & S. taper socket, and the cutters are positively driven by means of a clutch in the end of the spindle.

A flywheel weighing 250 pounds is mounted at the upper end of the spindle, and affords sufficient momentum to prevent vibration of the cutter or any irregularity of action when the cutter comes into contact with an exceptionally hard piece of work. The spindle is carried in a sleeve, to the upper end of which the speed-box casting is fastened. The lower spindle bearing is 4½ inches in diameter, and runs in a phosphor-bronze bushing, while the upper end of the spindle is carried by a combination of radial and thrust ball bearing. A clutch at the end of the spindle provides for positive driving of the cutter. Vertical adjustment is provided for the spindle sleeve by means of a graduated collar and a coarse thread on the sleeve. After adjustment, the spindle sleeve is firmly clamped in the split barrel of the ram.

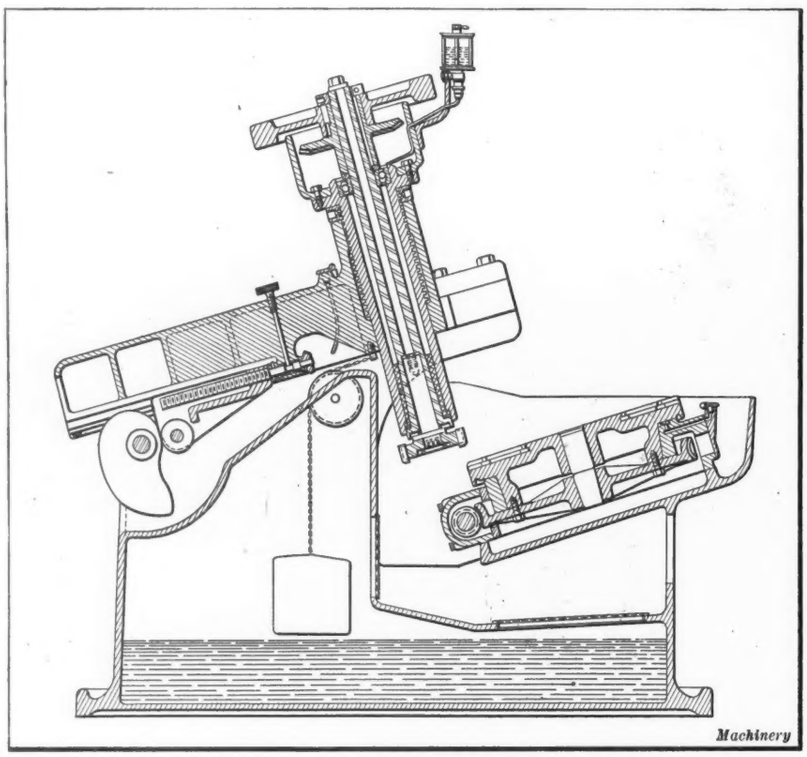



Fig. 5. Sectional View of the "Ohio" Tilted Rotary Milling Machine showing Details of Construction

### Design of the Bearings

A wear-resisting surface that resembles steel in its texture has been provided for the table surface and ram bearings, by a method of chilling the cast iron at the time it is poured in the foundry. Both the table seat and table surface are faced by the milling machine spindle in order to assure their perfect alignment with the spindle. Four hundred and seventy-five square inches of table bearing surface are provided, and one thousand square inches of ram bearing. These bearings are carefully scraped so that the full area of the bearings is effective. All gears used in the machine are made of hammered steel forgings, and they are subjected to four heat-treating operations which result in producing a hard outer skin and a tough metal beneath the surface. As a result, it is stated that these gears, which have been used on preceding models of Oesterlein machines, will not show wear throughout the average life of a miller, and that the teeth can be subjected to very severe shocks without breaking. The worms that drive the table and camshaft are hardened, and so are the index trip plates, index-cams, and plungers. Compensation for wear of the ram bearing is provided by accurately fitted gibs. Ball bearings are liberally used in the construction of this machine, but where it was not felt that bearings of this kind could be successfully employed, bushings made of bronze having a scleroscope hardness of 28 to 32 are used. Care taken in designing the bearings has resulted in producing a milling machine that will run at high speed with minimum friction losses. It is stated that graphic wattmeter tests show that when the machine is running idle, the power consumption is only 1½ kilowatt.

### Applications of the Machine

When this tool is used as either an indexing or a continuous rotary milling machine, the chief advantage secured is the elimination of idle time, which results in substantially increasing production. Where the indexing principle of operation is employed, with the radial feed movement for the cutter, the machine is able to handle certain classes of work which are not ordinarily handled on a production basis. For instance, it is quite possible to feed the cutter into the work for such operations as milling Woodruff keyseats or for facing off bosses and other surfaces which are so located that they would not be accessible to a stationary cutter and continuous rotary table. Another important application of the indexing principle of operating this machine is for milling small surfaces on large pieces of work, where the loss of time involved in continuously feeding the table would become prohibitive.

The application of an indexing mechanism on this machine permits of using two or more simple work-holding fixtures in place of a single large one that is adapted for holding more than one piece of work. This feature greatly broadens the field of usefulness of the machine, and often substantially reduces the expense of tooling up for a given job. By feeding the cutter radially over the surface of the work, the table is indexing while the cutter drops back to the starting point, which is an important factor in saving time, in addition to the time saved by rapidly indexing the table from station to station instead of feeding it continuously at a uniform rate of travel. Ample power is furnished to pull the cutters at a slow speed and high feed. Much of the mechanism which would be required to provide for quick adjustment of the machine has been omitted, in order to combine the features of simplicity of design and rigidity of construction. These features are more important than speed of adjustment in a machine that is to be used on the quantity production of duplicate parts. A 4-inch driving belt provides plenty of power for the heaviest cuts which will be required on manufacturing milling operations, and all parts of the machine are liberally proportioned to withstand the stresses to which they will be subjected under the most severe conditions of service.

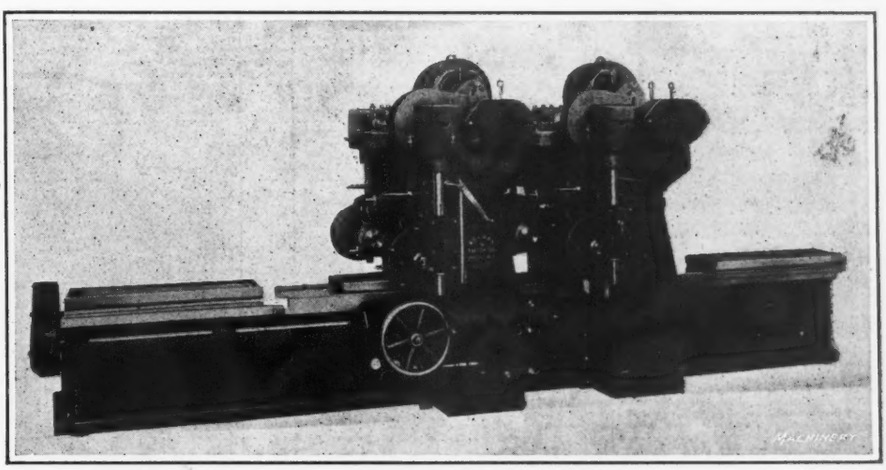
## BEAMAN & SMITH CONTINUOUS MILLING MACHINE

A heavy-duty manufacturing machine which is adapted for the rapid performance of milling operations has recently been placed on the market by the Beaman & Smith Co., Providence, R. I. It consists of a substantial bed to which uprights are attached. A pair of these uprights supports the horizontal spindle heads, and a cross-rail carries the vertical spindle heads. Each pair of uprights with its bank of spindles is one milling unit. As many spindles may be mounted on this unit as are necessary, and as many units may be attached to the bed as may be required to do the work. Usually two are sufficient—one unit for taking a roughing cut and the other for finishing. The feed driving machanism is carried on one unit only. Removable tables for carrying the work are fed continuously along the bed, taking a fast motion when the cutters are idle and a slow motion when the cutters are working. These tables, after having passed all of the cutters, are lifted from the bed and the finished work is removed. The unloaded table is then carried back to the starting point. Another table with the work already attached is placed on the front end of the machine and the process is repeated. As many tables are furnished with the machine as are necessary to maintain continuous milling, four being the usual number. Such machines will handle, on one trip of each table past the cutters, any milling required on two sides and on the top of any piece of work which comes within their capacity. By loading the tables to capacity, a large amount of work can be handled in a very short time.

In the accompanying illustration, there is shown a machine with two spindle-carrying units and removable tables. The machine, once started, need not be stopped until it is desired to change the cutters or to accommodate new work. The bed ways on which the tables travel are flat, with slight tapers on the inside edges to accommodate corresponding tapers on the bottoms of the tables. These ways center the tables without wedging them, and allow the tables to be put on and taken off rapidly. The tables hold themselves down by gravity, while traveling, except while passing the cutters. Here they pass under gibs which hold them against all vertical movement while the cuts are being taken. A feature of the table design is the narrow guide which is tapered. This makes for the maintenance of a greater degree of accuracy through a longer period than the common wide guide. There is a taper gib to take up wear.

A feed-shaft which runs the entire length of the bed and is driven from the front end, carries a series of worms spaced at such intervals that the traveling tables are picked up by one worm before they have completely left the other. These worms engage in a rack on the bottom of each table. The spacing of the worms makes it impossible to set a table down in the wrong position on the bed, and no matter where set it will pick up and travel instantly. The tables have feed in one direction, and fast motion controlled by hand in both forward and reverse directions. There are four changes of geared feed, providing a variation of from approximately 3 to 8 inches a minute, with a fast motion of about 12 feet a minute when the cutters are idle. Two changes of feed are secured through change-gears at one end of the gear-box and two more are obtained through a feed-gear shifting lever. The feed and fast motion are controlled by one lever which makes it impossible to engage both at the same time. The object of the feed-gear shifting lever is to slow down the feed as occasion may require. The feed mechanism is driven by means of a vertical shaft connected through bevel and reducing gears to the main driving shaft. Each unit is motor driven, the motor and driving mechanism being carried on the cross-rail which is supported by the uprights. The driving shaft is geared direct to the motor, and through reducing gears it drives the vertical and horizontal spindles. Through change-gears which are easily accessible, the spindles can be given various speeds.

The heads are cast in one piece and they are adjustable along the ways by means of hand-operated screws, wear being taken up by taper gibs. All have the feature of a narrow guide for maintaining accuracy of alignment. When a cutter is located, the head is clamped firmly in position. The spindles are furnished in three standard sizes, the largest diameter in the front bearings being 3⅝, 4⅝, and 5⅝ inches, respectively. All sizes can be incorporated on one machine and in heads located as occasion requires. They have hand adjustment in and out of the heads by a pinion and rack. The pinion is held in the head and the rack is on the spindle quill. The quill is held in its final position by being clamped. Careful attention has been paid to the provision of means for the oiling of all running parts. The machine is controlled at the unit which carries the feed-gears. Quality of finished work, rapidity of production, and ease of operation, are claimed to be the characteristics of this type of machine.



Continuous Milling Machine built by the Beaman & Smith Co.

## REEVES ROLL GRINDER

*The principal features of the Reeves roll grinder are: A cutting or grinding wheel running at regular grinding speed, which performs the grinding of the rolls or pins; a feeding wheel which rotates at slow speed and which gives both a rotary and a transverse feeding motion to the roll being ground; and a work-rest, which supports the roll on its under side while it is acted upon by the grinding wheel. The rolls are fed automatically past the grinding wheel; when ground, they pass from the machine in a chute to any convenient pan or box.*

A grinding machine for grinding rolls without holding them on centers has been designed by M. O. Reeves, and has been placed on the market by the Gardner Machine Co., Beloit, Wis. The working mechanism of this machine consists of a cutting or grinding wheel, shown to the right in Fig. 1, rotating in a counter-clockwise direction at ordinary grinding wheel speed; and a ring wheel, shown to the left in Fig. 1, which is of a fine, hard grain and grit, and which is rotated in a clockwise direction, when viewed as seen in the illustration, at a speed of about six revolutions per minute; this wheel is known as the feeding wheel. Between the two wheels is placed a work-rest upon which the roll to be ground rests while grinding. This combination of wheels

and work-rest, when properly adjusted, causes the roll to be ground to rotate with the same peripheral speed as the feeding wheel; and by placing the wheel-rest so that the center of the roll is in contact with the feeding wheel along a line slightly above the center of the feeding wheel, the roll is caused to advance or feed past the cutting wheel at any predetermined speed. In this way, the roll to be ground is fed past the cutting wheel automatically.

The process of grinding is continuous, one roll following another, making a constant even flow of rolls being fed past the cutting wheel. The amount of stock removed at each cut depends upon the character of the metal in the roll being ground and upon the accuracy and finish required. As an example of what can be done may be mentioned that in one instance a 1-inch roll with a scleroscope hardness of 80 was reduced an amount of about 0.005 inch, when passing through the machine for the roughing cut, and about 0.001 or 0.002 inch when passing through the machine for the finishing cut. The commercial accuracy that is easily obtainable under regular manufacturing conditions is stated to be from 0.0005 to 0.00025 inch. The machine is intended especially for the grinding of rolls up to 3 inches in diameter, and from ¼ inch to 5 inches long. It is applicable to the grinding of all round straight pieces such as rolls for roller bearings, piston-pins, bushings for various purposes, small drills, and pins requiring accurate outside diameter, etc.

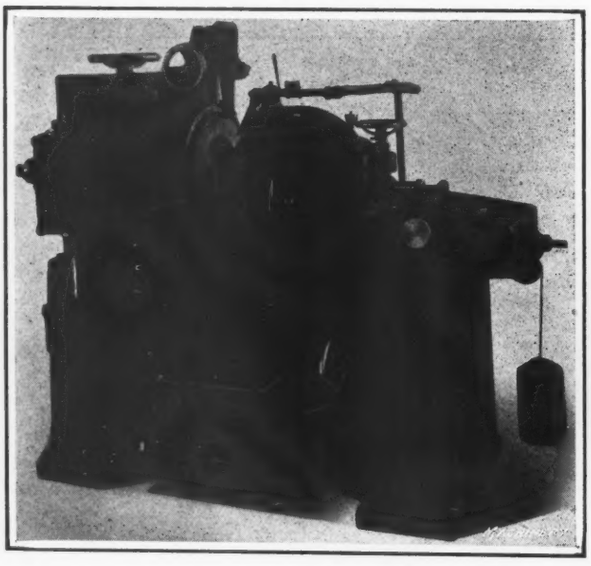


Fig. 1. Reeves Roll Grinder built by the Gardner Machine Co.

Fig. 2. Opposite Side of Roll Grinding Machine shown in Fig. 1

### The Grinding Wheel Head

The grinding or cutting wheel is mounted on a shaft the bearings of which are supported by the slide shown to the right in Fig. 1. The grinding wheel has a feed motion for wheel wear only. If there is too much stock on the rolls being ground to be removed in one grinding, they are run through the machine two or more times. Two wheel-speeds are provided—1143 and 1800 revolutions per minute—by means of a two-step cone pulley. The machine is designed for using a 16-inch wheel, and the higher speed is used as the wheel wears down. The driving cone for the grinding wheel is driven from a cone on the countershaft. The wheel-slide is actuated either by a handle on the squared end of the shaft, at the extreme right, in Fig. 1, which is used when the slide is to be moved by a rapid motion, or by the small hand dial on the side of the slide which provides a micrometer adjustment and which is connected to the feed-screw by means of a worm and worm-wheel. The hand dial on the side of the slide is graduated to 0.0001 inch, and the gearing is so calculated in connection with the lead of the feed-screw of the slide that one-fourth of a turn of the dial is equivalent to a motion of 0.001 inch of the slide and wheel.

The wheel-slide is counterweighted as indicated so that all backlash in the feed-screw and nut are taken care of. A dresser for the grinding wheel is provided at the rear of the wheel-hood, permanently mounted in place on the machine. The handwheel at the top of this dresser provides for a traverse motion of the diamond point, while the projecting knurled screw provides for the feed of the dresser.

### Feeding Wheel Head

The feeding wheel, which is a ring wheel, as shown to the left in Fig. 1, is mounted in a ring chuck and revolves at six revolutions per minute while grinding. Provision is made for change of speed while dressing the wheel, the dressing speed being 378 revolutions per minute. The feeding wheel is 16 inches in diameter. The drive for the feeding wheel head is by a single pulley from the countershaft to the pulley in the rear of the machine shown in Fig. 2. From the shaft on which this pulley is mounted the drive is by a pair of bevel gears and through a worm and worm-wheel for the slow drive; and for the fast motion for dressing, the drive is through the same pair of bevel gears and an additional pair of bevel gears and spur gears. The change from the slow to the fast speed is made by disengaging a clutch on the worm-wheel which latter runs idle on the spindle. When this clutch has been disengaged, the two spur gears mentioned are brought into engagement and thereby the fast drive obtained.

The driving wheel is adjustable in a vertical direction by means of the handwheel shown mounted on the top of the head to the left in Fig. 1. This adjustment takes care of the traverse motion of the roll to be ground. Locating studs are provided on the top of the work-rest casting—one in front and one in the rear of the machine. The tops of these studs are carefully ground so that they are absolutely horizontal with relation to the grinding wheel spindle, and are placed two inches below the grinding wheel spindle center. These studs form the gaging points for the work-rest, which latter is so set that the center of the work is central with the cutting wheel. Set-screws are provided for obtaining the vertical adjustment of the work-rest. After the work-rest has been so set that the center of the roll to be ground is properly adjusted with regard to the cutting wheel center, the driving wheel may be adjusted to feed the roll past the cutting wheel at any predetermined rate of speed. The further down the driving wheel is adjusted, the faster will the roll be fed past the cutting wheel. This machine will grind approximately 60 square inches surface measurement per minute. Each roughing cut will reduce the diameter from 0.006 to 0.010 inch and each finishing cut from 0.001 to 0.002

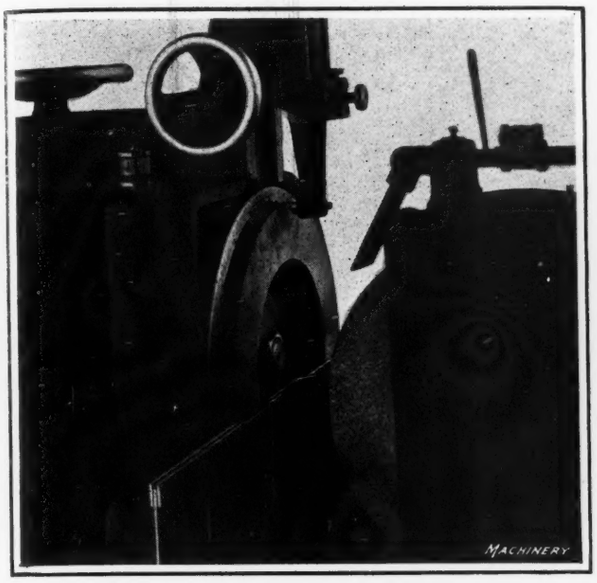


Fig. 3. Close View of Grinding Wheels, Work-rest, and Diamond Holder on Reeves Roll Grinder

inch. The above cuts and speeds vary on different materials and finishes.

The driving wheel is provided with a permanent dresser, as indicated at the top of the wheel-slide. The dresser is pivoted at the top and is fed inward by the small knurled head-screw shown in the front of the dresser casting, while it is moved up and down by means of the handwheel shown on the side of the dresser, immediately above the feeding wheel. Both this dresser and the one used for the cutting wheel are of very rigid construction and so located that they do not interfere in any way with the work being done on the machine. Both grinding wheels are also properly covered and guarded by hoods.

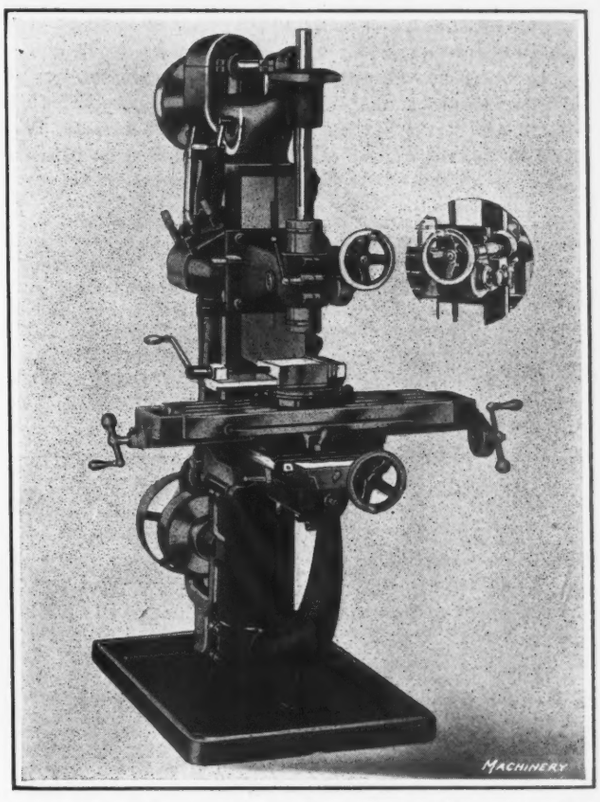
The base of the machine on which are mounted the three principal parts—the grinding wheel head, the driving wheel head, and the work-rest—contains a pan with a strainer; the lower part of the base forms a reservoir for the water used while grinding. The pump is driven from the countershaft by a separate pulley, as indicated in Fig. 2. The pump used is not of the regular geared construction, but of the propeller type, which is not affected by grit. An opening is provided at the bottom of the base for cleaning out the reservoir when required. At the right-hand side of the pan, as shown in Fig. 1, a handwheel is provided which actuates the work-rest longitudinally, so that the latter may be placed exactly below the center of the roll to be ground. The machine occupies a floor space of 4½ by 6½ feet, and weighs approximately 4600 pounds.

## KNIGHT MILLING AND DRILLING MACHINE

Several new features have been incorporated in the design of a No. 3 milling and drilling machine which has recently been developed by the W. B. Knight Machinery Co., St. Louis, Mo. The No. 3 machine is intended for heavier duty than that for which the preceding sizes are adapted, and for that reason all parts have been more liberally proportioned. The spindle is made of 60-point carbon steel, and the forging is ground to size after being machined. A solid bronze bushing 11 inches in length supports the spindle. This bushing is tapered so that it may be adjusted longitudinally to take up wear, the adjustment being accomplished by simply loosening one nut and tightening another. The thrust load is taken by washers made of bronze and hardened steel, which are oil grooved and ground to accurate finish. Adjustment is provided for the spindle head which, in connection with the vertical feed of the spindle, gives a maximum distance of 18 inches from the spindle to the table, while the distance from the center of the spindle to the column is 10 inches.

A special feature of the No. 3 Knight milling and drilling machine is the arrangement of the vertical feed. In addition to the longitudinal feed and cross-feed provided on previous machines of this company's manufacture, a vertical feed movement of 6 inches is provided for the spindle of the new machine. This feature is of especial importance where it is desired to use the machine for boring and drilling holes to a specified depth. The table is liberally proportioned to support heavy loads without danger of springing. Its working surface is 8½ by 33 inches in size, and three ⅝-inch T-slots are cut in the face of the table. These T-slots are of sufficient depth so that there is no danger of breaking out the metal around the clamping bolts which are employed for holding down the work. The table may be tilted to any angle up to 70 degrees, and a graduated dial provides for obtaining accurate angular settings. Provision is also made for pivoting the table about the column. This combination of movements is the means of saving a lot of time and labor.

A piece of work may be clamped on the table, and all of the surfaces parallel to the table may be milled and the holes drilled or bored; then, without moving the work, the table may be tilted in either direction to provide for performing boring, milling, and drilling operations at any desired angle with the surfaces of the work that have been finished. Furthermore, if it is required to take two or more cuts or to drill or bore more than one hole at points farther apart than the working surface of the table, by simply pivoting the table about the column, such operations may be readily accomplished. The table has a longitudinal feed movement up to 24 inches, and a cross-feed up to 10½ inches. Eight changes of spindle speed are available, ranging from 25 to 300 revolutions per minute, and eight spindle feed changes are provided covering a range from 0.008 to 0.060 inch per revolution of the spindle. There are also eight changes on both table feeds, which cover the same range.



Milling and Drilling Machine built by the W. B. Knight Machinery Co.

## KELLER UNIVERSAL CUTTER AND TOOL GRINDER

This machine was developed by the Keller Mechanical Engraving Co., Brooklyn, N. Y., for use in grinding round-nosed cutters and tracers that are employed on the Keller automatic die-sinking machine. It has many convenient features, but one of the most important of these is the ability to flute cutters right out to the end. In addition to its application on special die-sinking tools, this machine performs the following grinding operations upon any type of round-nosed cutters: Grinding on a tapered surface; grinding the hemispherical end or round nose of a cutter; grinding flutes, including those on the tapered portion of a cutter and on the round-nosed portion; and grinding a clearance on both the tapered portion and on the end or round-nosed portion.

It will be noted that two grinding wheels are used on the machine, both of which are mounted upon the armature shaft of a portable type of motor. The motor base slides horizontally in a dovetailed slide in the saddle and is fed horizontally by means of a lever at the right-hand end of the machine. There are adjustable stops located at the rear, which control the length of the ground portion of the work. The saddle is fitted to the standard by means of a dovetailed slide and it is adjustable in a crosswise direction to accommodate different diameters of cutters and tracers, or whatever tools are to be ground. This adjustment is effected by means of the upper ball crank handle at the front of the machine, which operates the cross adjusting screw.

The standard swivels from an upright cylindrical post around which the bracket opposite and above it also swivels. This standard can be set to grind tapers up to 45 degrees. A gage which determines the setting of the standard to suit the taper of the piece being ground, is not graduated; but the settings corresponding to tapers of 0, 7 degrees, 10 degrees, 15 degrees, and 45 degrees, are indicated on this gage. If there is a demand for it, a special gage could be supplied to indicate any desired setting. The vertical cylindrical post to which reference has been made, is adjustable vertically by means of the ball-crank located just below the pan of the machine.

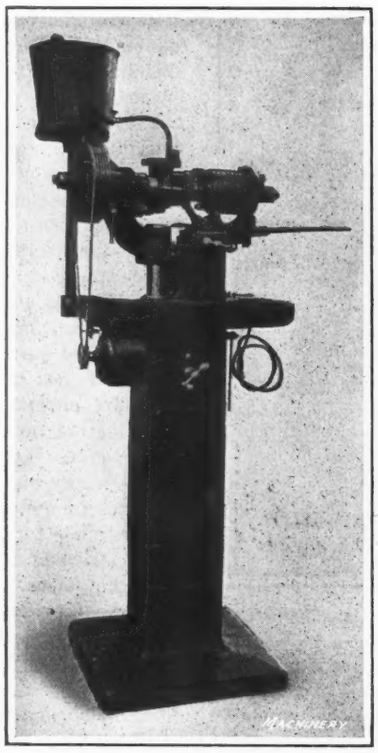


Fig. 1. Cutter and Tool Grinder built by the Keller Mechanical Engraving Co.

The work-holding bracket, in which the position of the spindle bearing can be adjusted by means of a dovetailed slide, can be swung through any angle up to 90 degrees. The location of the end of the round-nosed cutter in relation to the center line of the cylindrical post, (this adjustment is made possible by the dovetailed slide on the bearing casting and swiveling bracket) determines the radius of the nose on the cutter. When grinding the taper of a tracer or cutter, the tool is revolved by means of a small motor located just below the pan at the left-hand side of the operator. The drive is transmitted by means of a belt.

When this machine is used for fluting cutters, an indexing device that is provided on the fluting attachment is found very convenient. This device is made with notches milled on the outside circumference of a disk, the number of notches and their spacing depending upon the number and spacing of the flutes in the cutter. A locking bar securely locks the indexing device when performing fluting operations. The feed movement, as in all grinding operations, is accomplished by hand. In this particular case, the operator takes hold of the fluting attachment with both hands. While this machine was originally designed for the purpose of grinding round-nosed cutters and tracers that are used for die-sinking, it is also adapted for the grinding of other types of cutters, reamers, counterbores, spot-facing tools, and the tapered and fluted portion of taps. Other uses will readily suggest themselves to the experienced mechanic.

## "ABITZ" REVERSIBLE COUNTERSHAFT

The "Abitz" reversible countershaft, which is a recent product of the Rockford Metal Specialty Co., 720 S. Main St., Rockford, Ill., consists of a cast-iron pulley that is loosely mounted on the shaft. This pulley contains an internal

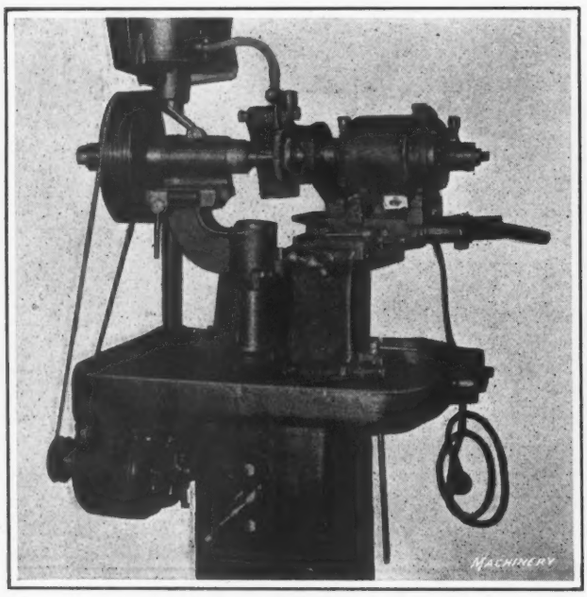


Fig. 2. Close View of Mechanism of the Keller Cutter and Tool Grinder

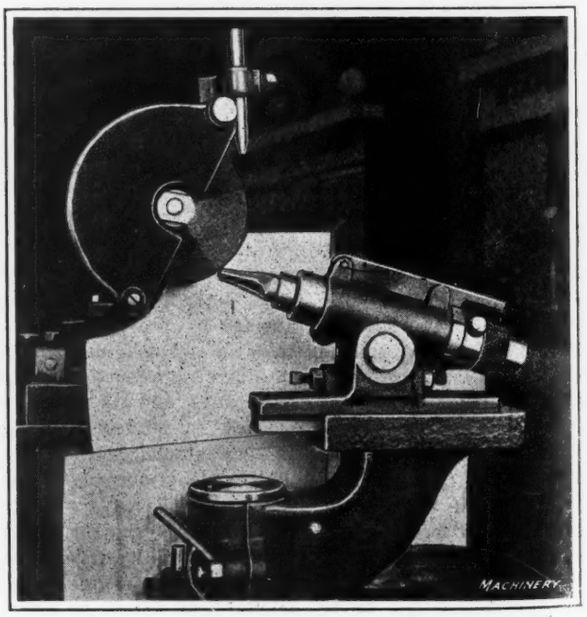


Fig. 3. Close View of Work-holding Bracket on Machine shown in Figs. 1 and 2

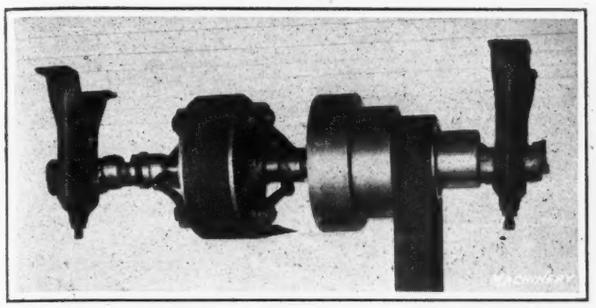


Fig. 1. "Abitz" Reversible Countershaft made by the Rockford Metal Specialty Co.

helical gear, and houses an idler drum, which is loosely mounted on the hub of the pulley and rotates in the same direction through the agency of a gear and a pinion fixed to an idler stud, forming a planetary rotation about a fixed gear on the shaft. A clutch at the right, which is fixed to the shaft, engages the pulley; and a stationary clutch on the left, which is loosely mounted on the shaft, engages the idler drum and acts as a brake. Two spools, fixed to one shifter arm, are provided to expand the clutches. It can be seen by referring to Fig. 2, that if the shifter arm is thrown to the left, the right-hand clutch is expanded, thus engaging the pulley and driving the shaft in the same direction, the whole mechanism revolving as one unit. If the shifter is thrown to the right, expanding the left-hand clutch, the idler drum will be held stationary, thus forcing the pinion to drive the gear fixed to the shaft, in the opposite, or reverse, direction. Hence, we have a forward, neutral, and reverse,

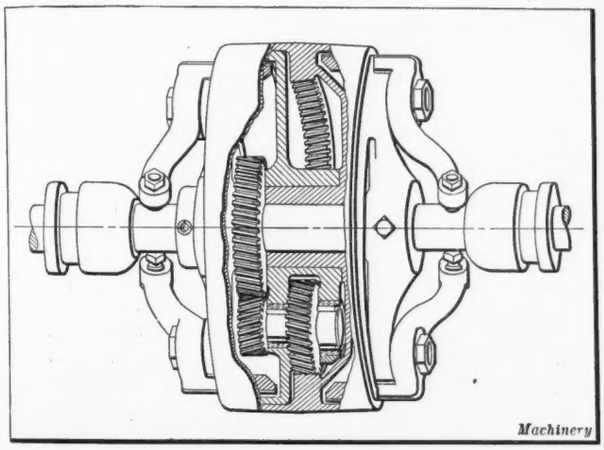


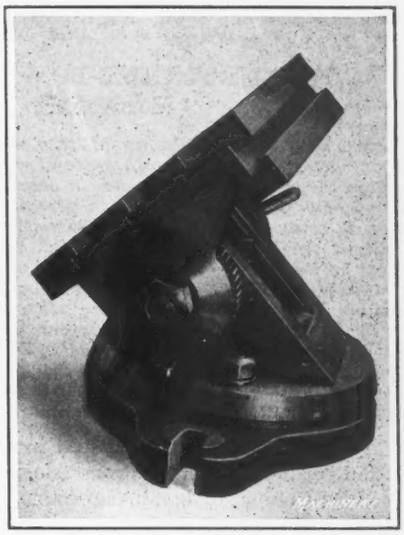

Fig. 2. Sectional View of "Abitz" Reversible Countershaft showing Details of the Mechanism

with a belt running in one direction, the gears only performing their function when the countershaft is in reverse, and when the shaft is at rest these gears merely run freely in their planetary path without having any influence upon the operation of the countershaft.

## NELSON UNIVERSAL ANGLE FIXTURE

The Nelson Tool & Machine Co., 253 Norfolk St., Newark, N. J., is offering to the trade a universal angle fixture which has a number of interesting features. The working surface of the angle-plate is 6 by 9 inches in size, and it has three T-slots and a finished face along one edge in which there is a T-slot. The latter feature is especially useful in handling many classes of work. A bolt that forms the horizontal axis about which the surface plate swivels is hardened and ground, and it is located off center on the base, thus clearing the base clamping bolt and contributing to the compactness of the fixture. This design brings the working surface of the angle fixture, when located in a horizontal position, exceptionally close to the base; and it also adds to the effect of liberally proportioned parts in providing an exceptionally rigid fixture. The degree of rigidity that is attained is demonstrated by the fact that the three T-slots are milled at the same time by a gang of cutters, while the surface plate is clamped in position on its own base. The working surfaces are finished by grinding and they are located exactly at right angles. Attention is called to the absence of overhang in any position of the surface plate. The swivel base is graduated throughout 360 degrees, and the swivel of the tilting table is equipped with beveled collars having graduations to 90 degrees.

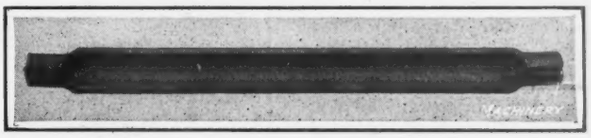
An important feature of this tool is the auxiliary clamping bolt, by means of which the table may be secured in position without disturbing the most accurate setting. This is accomplished by a hand-operated clamping screw which fits in a curved T-slot, binding the plate in the adjusted position and holding it securely against movement while the clamping bolt is tightened by means of a wrench that is supplied with the fixture. This fixture may be purchased with either a plain or a graduated swivel base. Adjustments may be easily and rapidly made. Adjustment of the table is accomplished by means of a small pinion which does not move with the table when making the adjustment. Dirt cannot become lodged between the clamping surfaces of this fixture; and in the swivel base type, two bolts prevent the swivel from lifting away from the base. An adjusting wrench is supplied with each fixture, and a hardened and ground sine bar attachment may be obtained as an extra equipment for the tool. This tool is made in three standard sizes: 6 by 9, 10 by 12, and 14 by 18 inches, so that a size may be selected to meet the requirements of work covering quite a wide range.



Universal Angle Fixture made by the Nelson Tool & Machine Co.

## NILSON TURNBUCKLE

In the accompanying illustration, there is shown a turnbuckle that is made by an improved method developed by the Nilson Die & Tool Co., 319-331 W. Ohio St., Chicago, Ill. An interesting feature of this turnbuckle is that it is made from a stamping, through the use of an improved method which not only requires an exceptionally small amount of stock, but also saves the cost of labor which would be required for drilling the holes preparatory to tapping them.



Improved Type of Turnbuckle made by the Nilson Die & Tool Co.

According to the method by which this turnbuckle is made, the ends are rolled up to form two cylindrical openings in which the threads may be tapped. Both the cost of labor and of material are reduced by this method of manufacture. The same principle can be applied in the production of various styles and sizes of turnbuckles, and similar products.

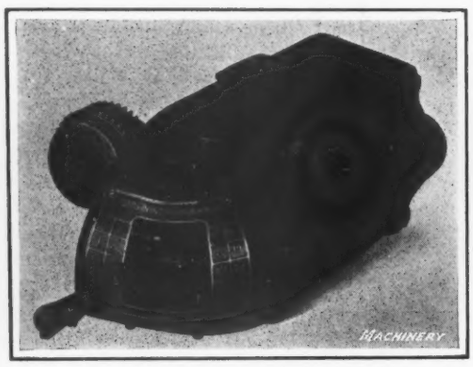


Fig. 2. Outside of Feed-box which is mounted at the Right-hand Side of the Knee

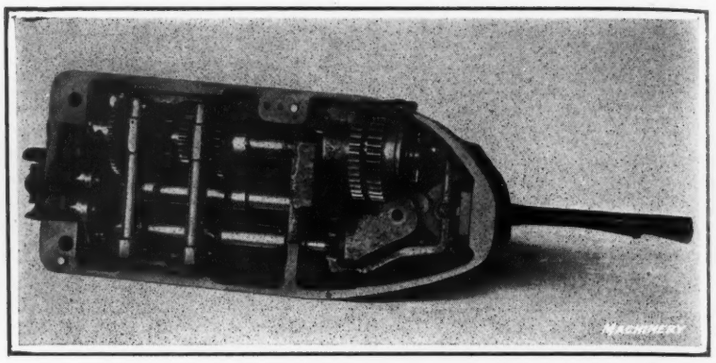


Fig. 3. Inside of Feed-box showing how Selective Feed Change-gears are arranged

## CINCINNATI HIGH-POWER MILLING MACHINE

*In working out the design of this machine, all members have been proportioned with especial reference to the stresses which they will be called upon to bear when the machine is using wide-spaced cutters with stream lubrication. Provision is made for utilizing an automatically controlled intermittent feed movement, with rapid power traverse of the table between feed movements, which is the means of greatly reducing the idle time between successive cuts. Various combinations of feed and traverse movements may be utilized to meet the requirements of different jobs, both the feed and rapid traverse movements of the table being automatically controlled by dogs. Attention is called to the over-arm construction which represents a noteworthy departure from established practice in milling machine design.*

At the time when high-speed steel was first produced, many of the cutting tools made from this material failed to accomplish results that fulfilled claims made by the steel maker. This was often due to the fact that such tools were used on machines with sufficient power to drive carbon steel tools to the limit of their cutting capacity, but which failed to deliver the additional amount of power required to obtain a similar result from high-speed steel tools. As high-speed steel came into general use, machine tool builders found it necessary to redesign their product to furnish additional strength, rigidity, and driving power, to provide for operating these improved cutting tools at the limit of their capacity.

A somewhat similar—although less marked—trend has been observed in milling machine design during recent years, the provision of greater strength and power being made necessary by the development of the so-called wide-spaced cutters which are adapted for exceptionally heavy work, and the application of stream lubrication, which also increases the productive capacity of milling cutters. When starting to design the No. 5 plain high-power miller which has recently been placed on the market by the Cincinnati Milling Machine Co., Cincinnati, Ohio, data setting forth the results of these two developments in milling practice were carefully considered, in order that every important element of this new milling machine might be made entirely adequate for handling the most severe classes of production work. It is claimed that this careful consideration of modern operating conditions has resulted in the development of a miller of exceptionally rugged construction, and one which is unusually convenient to operate for a machine of this rating.

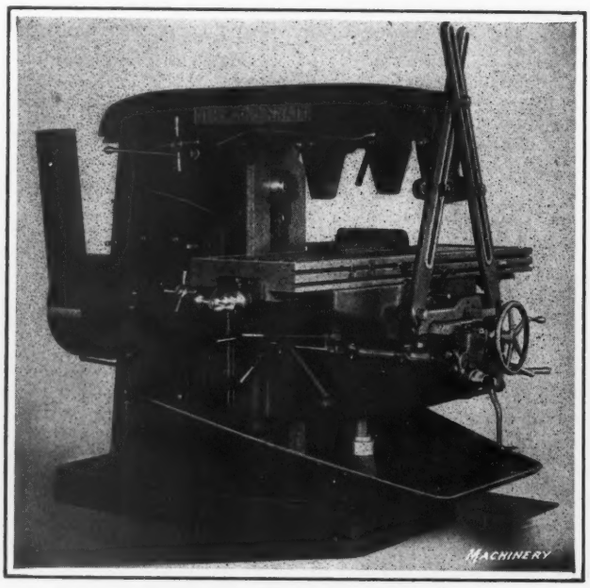


Fig. 1. No. 5 High-power Plain Milling Machine recently developed by the Cincinnati Milling Machine Co.

### Structural Features of Design

Reference to the illustration of this new Cincinnati milling machine presented in Fig. 1, will show that in some respects the designers have made noteworthy departures from established practice. The over-arm is made of rectangular form, with V-bearings by which it is supported on the column. This over-arm supports the arbor bearings and assures their perfect alignment at all times. A rack and pinion operated by a pilot wheel make lengthwise adjustment of the over-arm an easy matter. Square gibbed bearings with narrow guides are provided for the knee bearing on the column, and for the saddle bearing on the knee. They are provided with lengthwise adjustable tapered gibs, and the construction has been worked out in a way which provides for permanence of alignment.

A brake is provided on the starting lever, which automatically comes into action when the clutch has been disengaged, thus bringing the spindle to a quick stop. There is a spindle reversing mechanism on the machine which provides for running it either right-hand or left-hand, by simply shifting a lever. The standard Cincinnati flanged end has been provided at the front extremity of the spindle, thus making provision for interchanging face milling cutters between this machine and other sizes of Cincinnati millers. Changes of speed are accomplished by a mechanism which is very simple to operate. To change from a given speed to any other speed, it is merely necessary to set the levers to figures indicating the desired speed.

### Arrangement of the Feed Mechanism

Figs. 2 and 3 show the outside and inside of the feed-box which is mounted at the right-hand side of the knee, at the front. Feed changes are obtained by means of a single lever best shown in Fig. 2. This lever is within easy reach of the operating position at the front of the machine, and it may be moved up and down, from side to side, or diagonally. This freedom of movement enables any required rate of feed to be obtained directly and by a single movement of the lever. In addition to the individual feed engaging and reversing levers at the front of the knee, there is also a similar set of levers at the rear of the knee for operat-

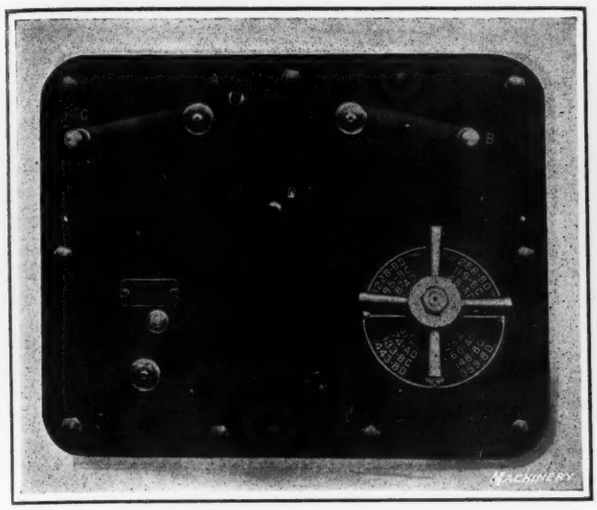


Fig. 4. Outside of Spindle Speed Change Box

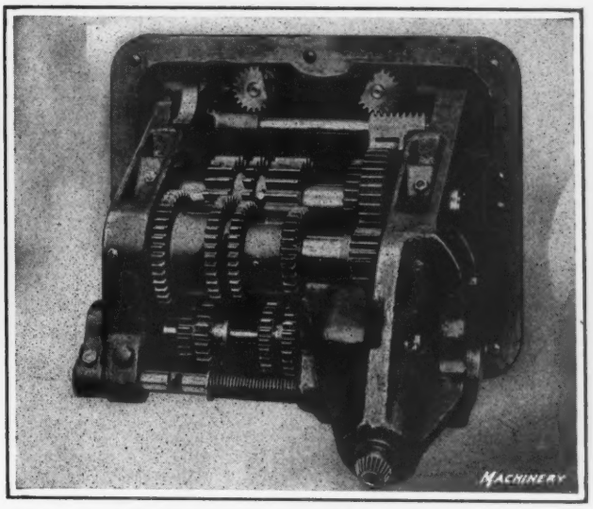


Fig. 5. Inside of Spindle Speed Change Box

ing the longitudinal, cross, and vertical feeds from behind the table, this feature being especially convenient when performing end-milling, face-milling, boring, and similar operations.

### Intermittent Feed and Power Rapid Traverse

This machine may be furnished either with or without an intermittent feed mechanism. Control of the feed and power rapid traverse is accomplished by means of a table hand-feed lever; and the table may be automatically stopped at any point in its travel by using dogs in the usual way. Application of this intermittent feed mechanism does not in any way complicate the machine, as the intermittent feed with automatic reverse and power rapid traverse is brought into use by simply adding the necessary dogs. If these dogs are removed, the operation of the feed is exactly the same as that of a milling machine of standard design. Various combinations of intermittent feed and rapid traverse may be employed to reduce the idle time while the table is moving across the spaces that must be traversed in order to bring successive pieces of work into the operating position. For instance, a string of pieces of work may be set up on the table and dogs may be arranged to feed each of these pieces under the cutters at the proper rate, and then employ rapid power traverse to move the table along until the next piece of work comes almost into engagement with the cutters, at which time the feed movement is again automatically engaged. This is only one example of the numerous ways in which this intermittent feed mechanism can be used.

A single lever with five operating positions starts, stops, and reverses both the power feed and the power rapid traverse. The traverse movement is at the rate of 100 inches per minute. Sixteen changes of feed are available, which are in geometrical progression from ¾ inch to 30 inches per minute; but feeds from ⅜ inch to 15 inches, or 1⅛ inch to 45 inches per minute, can be obtained, if desired, by substituting change-gears which are furnished on special order. Since the feed-change lever is at the front of the machine, one movement of this lever always enables the operator to engage the standard maximum feed of 30 inches per minute, and this provides a convenient quick traverse for the comparatively short cross and vertical movements that are available on this machine.

### Provision Made for Lubricating Bearings and for Cooling Cutters and Work

A patented automatic oiling system is provided for the spindle bearings, driving gears, and other rotating parts in the column. In addition, there is a centralized lubricating system that consists of six oiling stations for the other mechanisms of the machine. An eleven-gallon centrifugal pump connected with a large reservoir in the machine base provides for delivering a copious flow of coolant to the work, which effectually overcomes troubles which are likely to be experienced through excessive heating.

### Application of Individual Motor Drive

It will be apparent from Fig. 1 that the machine shown in this illustration is equipped with a constant-speed pulley for belt drive. Where individual motor drive is to be employed, the driving motor is most conveniently mounted on an extension of the base, at the rear of the machine, and direct connected by gearing. With this arrangement, any make of motor may be employed, and the motor speed may be anywhere from 750 to 1500 revolutions per minute. The gears are contained in a completely enclosed oil-tight casing, which provides for their automatic lubrication, and they are hardened and run on ball bearings.

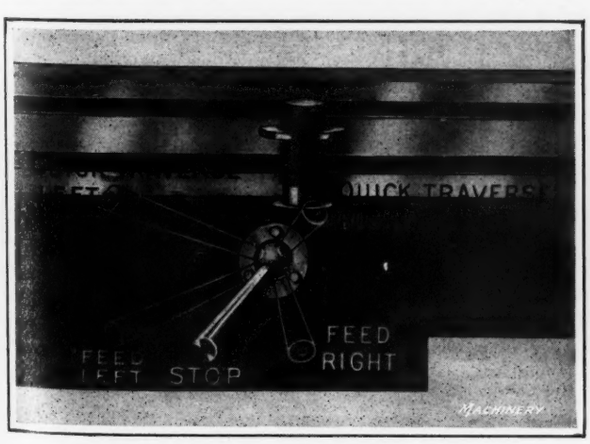



Fig. 6. Positions of Table Feed Lever at Front of Saddle

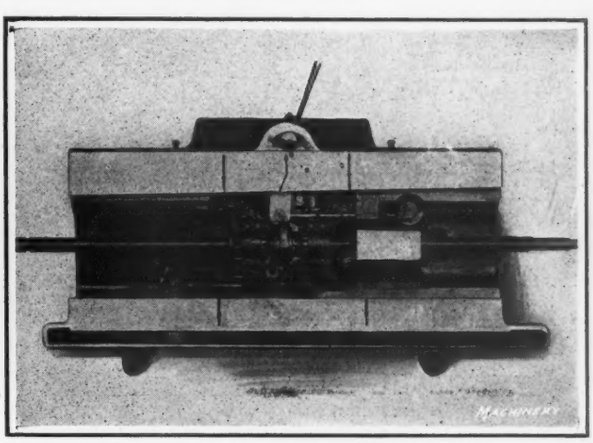


Fig. 7. Inside of Saddle showing Arrangement of Mechanism

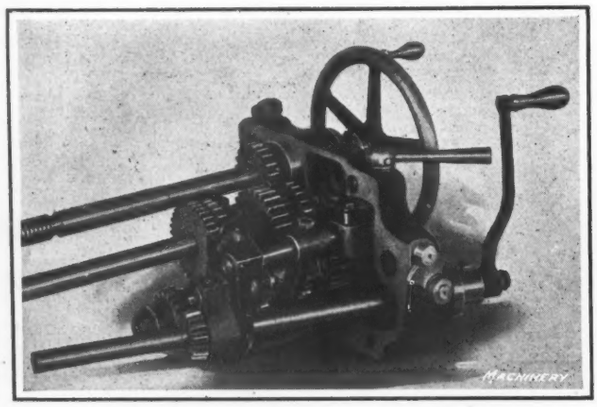
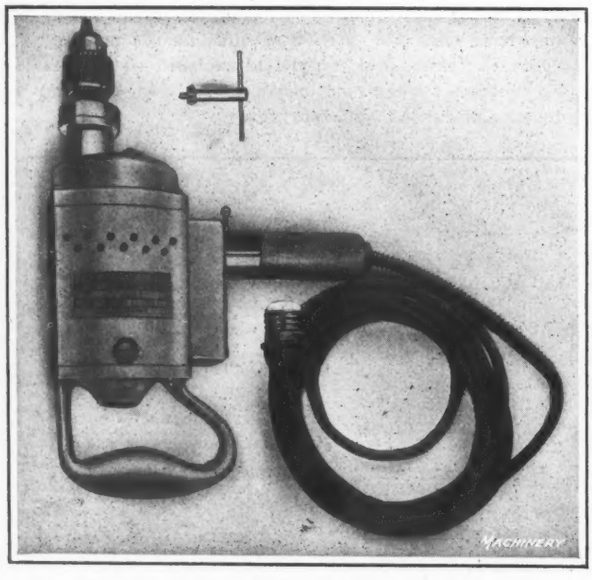


Fig. 8. Arrangement of Feed Gearing in the Knee

The principal dimensions of this machine are as follows: Size of working surface of table, 79 by 21 inches; capacity of dividing head, for work 14 inches in diameter by 56½ inches long; range of feed movements, 50 inches longitudinal by 21 inches vertical by 14 inches cross; size of driving pulley, 16 inches in diameter by 6 inches face width; diameter of spindle in front bearing, 4 1/16 inches; taper of socket in the spindle, No. 14 B. & S.; diameter of hole through spindle 1 1/4 inch; range covered by sixteen available spindle speeds, 16 to 443 revolutions per minute in either direction; range covered by sixteen available rates of feed, 3/4 inch to 30 inches per minute (by using change-gears, two additional feed ranges from 3/8 inch to 15 inches or from 1 1/8 inch to 45 inches per minute, are available); capacity of centrifugal coolant pump, 11 gallons per minute; dimensions of vise jaws, 10 inches wide by 2 inches deep, with a maximum opening of 10 inches; floor space occupied by machine, 104 by 149 inches; and net weight of belt-driven machine, approximately 11,000 pounds.

## STOW PORTABLE ELECTRIC DRILL

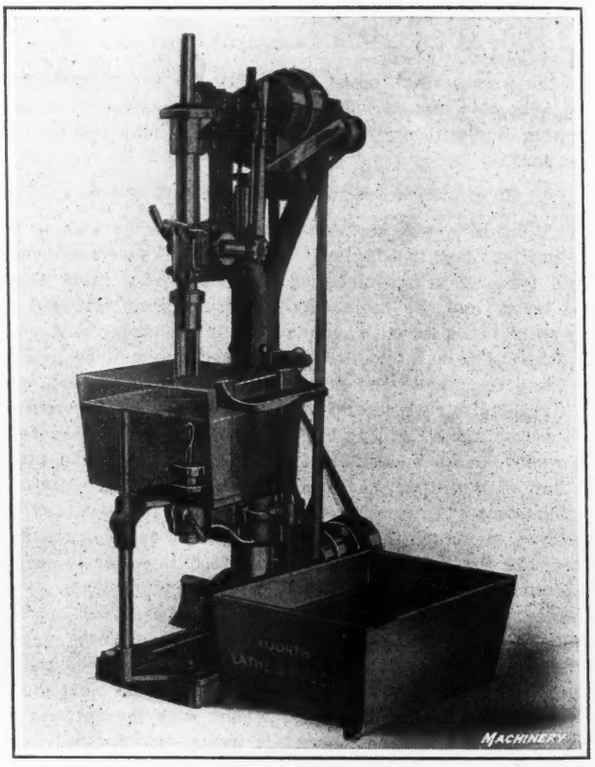
A small portable motor-driven drill that has a capacity for drilling holes up to 1/4 inch diameter in metal and 5/16 inch diameter in wood has been developed by the Stow Mfg. Co., Binghamton, N. Y. An illustration of this drill, which is known as the S-I-U type, is presented in connection with this description. It is equipped with ball bearings and is operated by a motor at either 110 or 220 volts. The approximate speed of the loaded spindle is 1000 revolutions per minute, and the motor develops a maximum of 1/8 horsepower. The weight of the drill is only six pounds, which allows it to be readily handled, this being an important factor in the use of all tools of this kind. The principal dimensions of this tool are as follows: Length over-all with chuck, 11 inches; diameter of motor frame, 3 inches; and offset of drill spindle from edge of frame, 15/16 inch.



Portable Motor-driven Drill made by the Stow Mfg. Co.

## HJORTH SUBMERGED DRILLING ATTACHMENT

The Hjorth Lathe & Tool Co., 27 School St., Boston, Mass., has produced a drilling attachment, for use on upright drilling machines, where the drilling is done with the drill entirely submerged in oil. The drill remains stationary and the work revolves during the operation. An illustration of this attachment is shown in connection with the following description. A tank, which is shown in phantom form, is attached to the drilling machine table socket. There are two centering holders, one of which is attached to the base



Attachment made by Hjorth Lathe & Tool Co. for drilling Work submerged in a Bath of Coolant

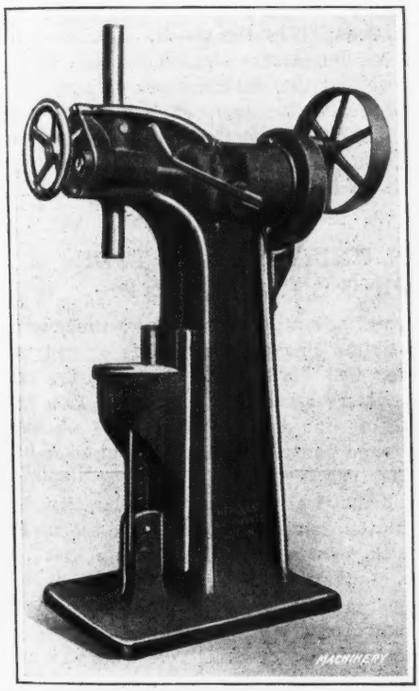
of the machine and the other to the bottom of the tank. A cylindrical rod is supported by the lower holder, on which a bearing on the upper holder slides vertically, thus keeping the tank in alignment as it is raised or lowered. The drill is carried in a holder which is secured to the bottom of the tank. This drill-holder is adaptable for any drill from ¼ up to 1½ inch in diameter, and ordinary lengths of drills up to ⅞ inch in diameter can be lowered into the holder, in order to shorten the distance from the point of the drill to its support.

The drill is self-centering in the socket drill-holder. The stock under operation is held in a chuck, attached to the drill spindle, and the chuck is so constructed that if the length of the stock requires the adoption of such a practice, the stock may be removed from the chuck and redrilled from the opposite end, after it has first been drilled to the full capacity of the spindle movement, thus allowing the stock to be drilled to twice the length of the spindle movement. It is claimed that this attachment prevents the heating of the work under operation, eliminates wear on the cutting edges of the drill, keeps the drill constantly lubricated, keeps chips and shavings from sticking to the drill and from clog-

ging it, by a circulation of a compound in the tank, and that the revolving of the stock under operation keeps it perfectly centered, thus making the drilling absolutely true. A movable shelf for tools, wrenches, and drills is provided, which may be attached to the tank on the drilling machine table socket, or to another tank placed on the floor beside the machine, into which the oil is emptied from the upper tank when it is desired to remove a drill from the drill-holder.

## HERCULES POWER PRESS BROACH

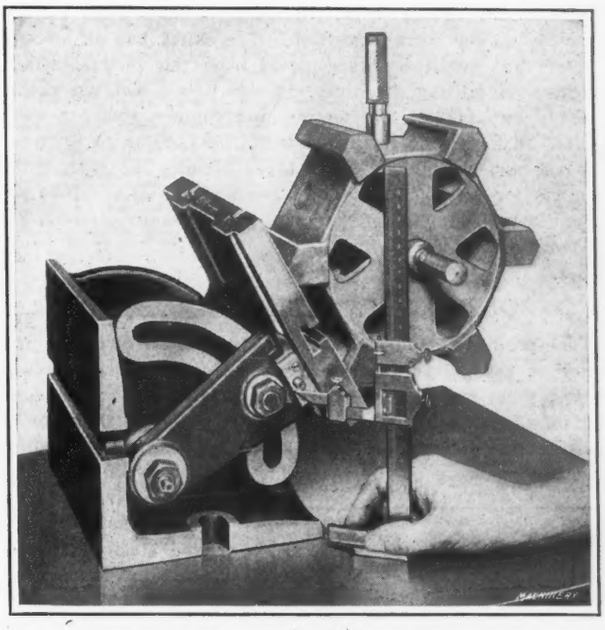
The Hercules Machinery Co., Union Trust Bldg., Detroit, Mich., has recently placed on the market a machine which is adapted for pressing, and draw- and push-broaching operations. The working elements of the machine consist of a ram to which motion is transmitted by means of gearing that is controlled by one lever through a system of friction clutches. By means of this lever, three different speeds of the ram are obtained. In order to insure perfect alignment, the ram is keyseated for its entire length. The machine is adaptable for a large variety of operations requiring pressure, such as forcing arbors, bushings, shafts or pins in or out of holes, seats into valves, linings into pumps, straightening, bending, forming, sizing holes with hardened plugs, testing castings, etc. It is also adapted for the rapid quantity production of all broached parts. A knee is carefully fitted to machined ways on the front of the column, which has a shear pin support, thus making overloading impossible and avoiding the breakage of parts. The knee can be removed and replaced with other fixtures that may be required for different draw- or push-broaching, or other operations. The principal dimensions are as follows: Greatest distance from top of table to end of ram, 34 inches; largest diameter hole through table, 4½ inches; speed of ram on fast down and quick return movement, 50 feet per minute; slow or power down travel, 7 feet per minute; will press to center of 24 inches diameter; net weight, about 1750 pounds.



Power Press Broach made by the Hercules Machinery Co.

## IMPROVEMENT IN TAFT-PEIRCE TOOLMAKER'S KNEE

The T-P toolmaker's adjustable knee was formerly provided with a measuring plug at the center of rotation of the knee and a bushed and lapped hole in the table of the knee, so that by inserting a suitable plug in the hole, accurate measurements could be made by utilizing the two plugs as a sine bar. The Taft-Peirce Mfg. Co., Woonsocket, R. I., has improved this tool by substituting a second measuring plug for the hole in the table, the distance between the two measuring plugs being exactly 5 inches. This arrangement not only greatly facilitates the manipulation of this tool when making accurate measurements, but it also simplifies the calculation of the angles.

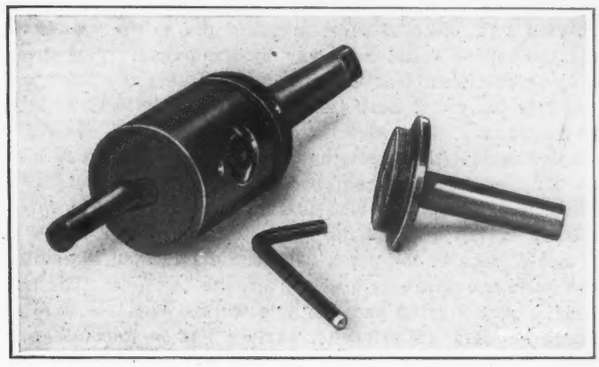


Toolmaker's Knee with Sine Bar Attachment made by Taft-Peirce Mfg. Co.

The outer measuring plug, instead of being inserted in the edge of the table, is mounted in an adjustable plate which is held in position by two dowel-pins that are inserted when the knee is finally finished. In case it is ever necessary to repair the knee, this plate can be readjusted and re-doweled so as to restore its original accuracy. The base of the knee is finished on two right-angle faces, which permits it to be set at any angle from 0 to 90 degrees and yet make the measurement of an angle of 45 degrees or less, which gives the highest degree of accuracy in observation. In the accompanying illustration the knee is shown in use. It is being set to the complement of the required angle after which it will be turned on the other face of the base and measurements made to the plug which is shown in the vertical position in the jig. The location of one of the measuring plugs in the knee at the center of rotation eliminates a great deal of measuring as it does not change its position when setting the table. Both measuring plugs are protected from damage by massive parts of the knee which extend beyond them.

## MEYERS ECCENTRIC BORING CHUCK

A No. 0 eccentric boring chuck that has been developed by the W. F. Meyers Co., Bedford, Ind., is here illustrated and described. This chuck is especially adapted for tool, jig, and fixture work where the boring of different sized holes with one tool is necessary. All the wearing parts are hardened, tempered, and ground. A feed-screw which is



Eccentric Boring Chuck made by the W. F. Meyers Co.

graduated in thousandths of an inch, is used to set the boring tool in the correct position. The chuck has an ejecting collar that facilitates its removal from the vertical attachment of a milling machine. It also has a locking washer that eliminates all lost motion and compensates for wear. This chuck may be furnished with No. 7, 9, or 10 Brown & Sharpe taper shanks, Morse taper shanks, or with collet shanks for bench lathes, etc. Some of the dimensions are as follows: Diameter of body, 1¾ inch; length of body, 2⅛ inches; and offset, ⅜ inch.

## OLIVER PROFILING MACHINE

The profiling machine illustrated in Fig. 1 is a recent product of the Oliver Instrument Co., Adrian, Mich., and in Fig. 2 there are shown some typical examples of work done by this machine. In order to give an idea of the rate of production which may be attained on this new profiler, mention is made of the fact that the largest of the three parts shown in Fig. 2 was cut from cold-rolled steel 3/32 inch thick, in four minutes. It will be seen from Fig. 1 that this machine is built on the lines of a punch press, with a deep throat and a very short stroke. The punch used is round in section and has a heel on the back which does not rise out of the die when the machine is in operation. There is an eccentric bearing in the head, by means of which the punch can be raised 3/8 inch, and when in this position the work will pass under the punch and can be set in position to have a hole worked out.

Fig. 1. Profiling Machine developed by the Oliver Instrument Co.

In the manufacture of typewriters, adding machines, cash registers, airplanes, and similar products which require parts that are made from sheet metal, it is sometimes necessary to produce from ten to several hundred parts of a given shape without the use of dies. This machine provides a most economical method of producing these parts. A templet is first made to the exact shape of the part desired, and this templet is doweled to a piece of sheet metal of the thickness desired and the excess metal cut away by the punch. The stroke is so proportioned that the punch clears only the stock and cuts into the metal until the templet rubs against the body of the punch. The work is guided by hand, keeping the templet against the punch until the entire outline has been cut out. If the work has openings, as at *A* and *B*, Fig. 2, a hole is drilled which will admit the punch. An eccentric bearing on the head of the machine permits the punch to be raised clear of the die a sufficient distance to insert the work, and the punch is lowered through the hole. The machine is then started and the hole worked out the same as though it were an extension surface. It is impossible to over-run the finished outline, and the work comes from the machine practically finished. It is only necessary to remove, by filing, the small scallops left by the punch. The machine is motor driven and has an interlocking switch and brake arranged in such a way that the machine runs only as long as the foot is on the pedal. The speed is 250 strokes per minute. The stroke is 1/4 inch and the machine will work any stock up to 5/32 inch thick in steel. The total weight of the machine is 601 pounds.

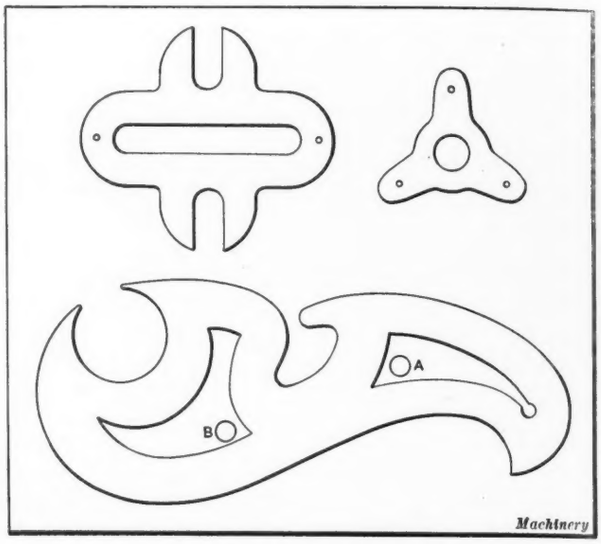



Fig. 2. Examples of Work done on the Oliver Profiling Machine shown in Fig. 1

## THOMPSON UNIVERSAL CUTTER GRINDING ATTACHMENT

The universal cutter grinding attachment here illustrated is a recent addition to the line of attachments offered by the Thompson Grinder Co., Springfield, Ohio, for use on their 10- by 36-inch universal grinding machine. This attachment adds greatly to the types and sizes of cutters that may be ground upon the machine. It is universally adjustable and also has the distinctive feature of holding a taper as well as a cylindrical arbor. A circular base is keyed to the T-slot in the grinder table, and on top of it rests the bracket which rotates on the base, this bracket being furnished with graduations that coincide with those on the base. The upper portion of the bracket is finished off radially, with a central stud on which the vise swivels. There are graduations on the bracket that match with those on the vise, and it is possible to swivel the vise through 180 degrees.

The cutter-arbor is held in a V-groove in the vise and is drawn into place by an adjustable block. This block is

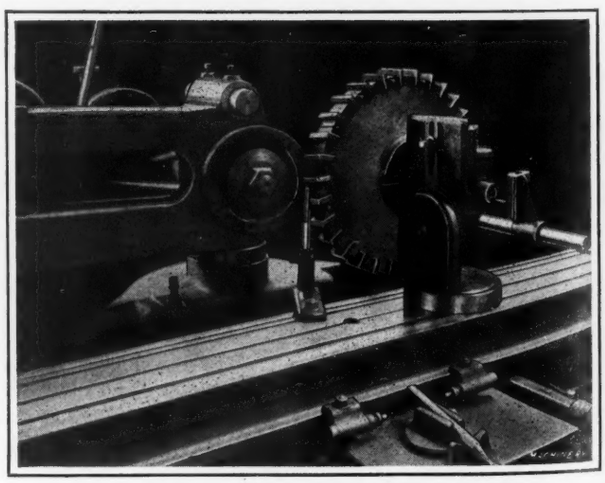


Fig. 1. Universal Cutter Grinding Attachment made by the Thompson Grinder Co.

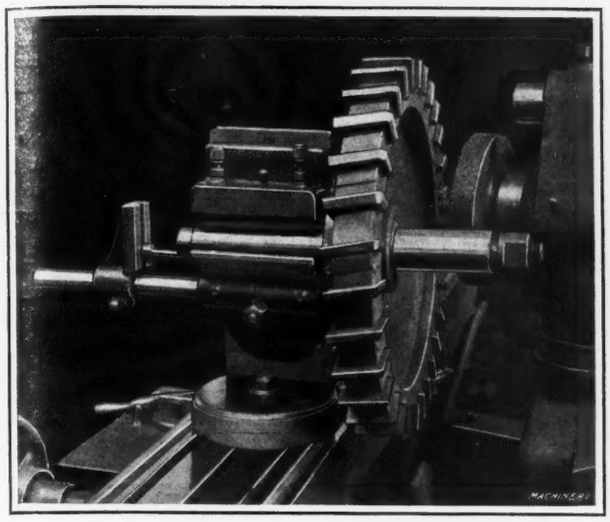


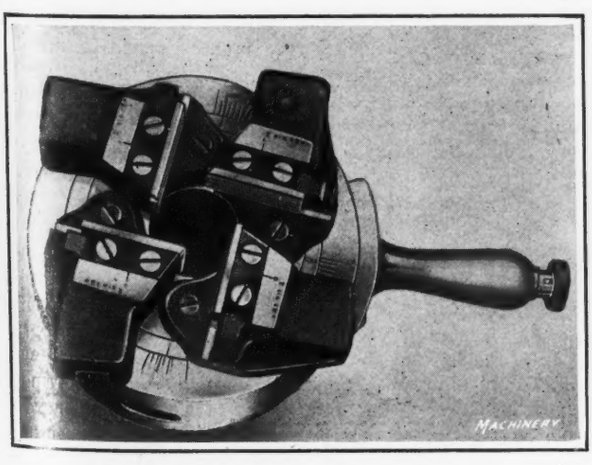
Fig. 2. Opposite Side of Thompson Universal Cutter Grinding Attachment

adjustable for a large variety of arbor sizes up to 2¾ inches in diameter, and clamping is accomplished by two knurled set-screws which back up the steel block. As there are two set-screws, the adjustment is variable and allows a taper arbor to be as readily held as a cylindrical arbor. The only additional feature is an adjustable stop-pin held on a slotted bracket, which slides in and out on a rod that projects outward from the vise. This stop-pin limits the movement of the cutter-arbor so that longitudinal movement is very accurately controlled, which is a most important thing in the grinding of large expensive cutters.

## LANDIS THREADING DIE-HEAD

The Landis Machine Co., Inc., Waynesboro, Pa., has placed on the market a new style of automatic screw cutting die-head which is different in design from other heads of this type, in that the chasers are supported on the face of the head. This permits of easy access to the chasers when it is necessary to remove them for grinding and changing from one diameter to another. The tool is made of steel and its sturdy construction insures satisfactory service. It is opened automatically by retarding the forward motion of the carriage, and is closed by hand. Locking is accomplished by the operating handle which contains a latch having a tongue milled on the lower end, this tongue being milled off center to permit of taking roughing and finishing cuts. To adjust the head for either roughing or finishing cuts merely requires a half turn of the latch.

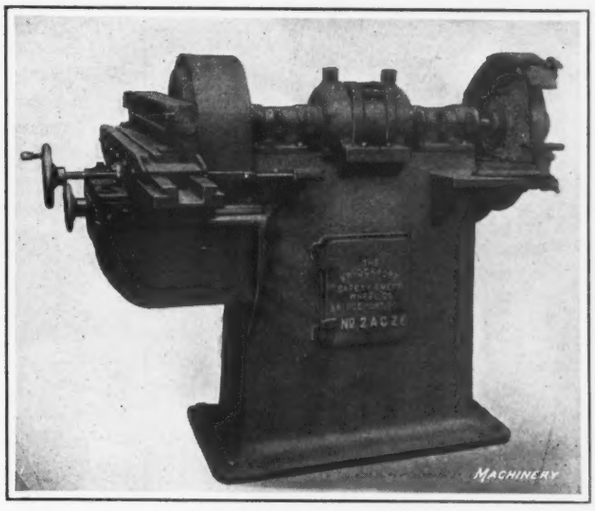
This die-head is graduated for threading all sizes of bolts and pipe, both right and left hand, which come within its range. It is adjusted to size by means of an adjusting screw that engages the head body. Since the operating, adjusting, and closing rings remain in a fixed position when the head is closed, the rotating of the head body within these rings gives the various diameters that come within the range of the head. To set the head for left-hand threading, the screw which locks the latch-pin is removed and the latch-pin is rotated to the left-hand graduation. The locking screw is then replaced and left-hand holders are attached. This die-head is applicable to practically all makes of screw machines and turret lathes which have sufficient space to swing die-heads of these diameters, and it will handle thread cutting operations on a wide range of work.



Threading Die-head made by the Landis Machine Co.

## BRIDGEPORT COMBINATION GRINDING MACHINES

Several types of combination grinding machines that are especially adapted for use in shops where a limited amount of work of a particular kind is done, have been produced by the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn. These machines are really two machines in one and require little more space than would be necessary for one machine. The floor type of machine known as the No. 2 A.C.Z.E. is shown in the accompanying illustration. The base is of a heavy cabinet construction and has a bracket that



No. 2 A. C. Z. E. Grinder produced by the Bridgeport Safety Emery Wheel Co., Inc.

is cast integral with it. This bracket is on the left-hand side of the machine, and its top is planed to hold a gibbed dovetailed table which is fed up to the grinding wheel by a handwheel and screw. There is a bed on the top of this table which is pivoted at the center so that it can be tilted in order to grind slightly concave, or it may be set square for grinding flat work. It is secured in the desired position by means of clamping screws at each corner of the bed. On top of this bed there is a carriage that slides over a dovetailed track, which is moved back and forth in front of the grinding wheel by means of a handwheel that engages a pinion with the teeth of a rack on the under side of the carriage. There are two T-slots on the top of the carriage which permit the work to be clamped to it, or a magnetic chuck or a number of fixtures can be supplied for this purpose.

This machine may be furnished with a revolving knife-bar for grinding machine knives, as shown at the left, or for plain surface grinding. One thick wheel is shown at the right-hand end of the machine, but three thin wheels will be furnished if so desired. The type of machine known as the No. 6 A. C. E. Z., while practically the same as the machine described, is modified for wet grinding at the right-hand end. A twist drill attachment may also be applied at the right-hand end of the machine instead of the wheel

shown in the accompanying illustration. These machines may be driven by either alternating or direct current or by belt. A few of the principal dimensions are as follows: Height from floor to center of spindle, 40 inches; distance between wheels, 35 inches; size of carriage, 34½ inches long by 6 inches wide.

## TAYLOR & FENN VERTICAL MILLING MACHINE

The Taylor & Fenn Co., Hartford, Conn., is now building a vertical-spindle milling machine which is adapted for operation at extremely high cutter-spindle speeds. This machine is suitable for the performance of various light vertical milling operations, and it may also be used as a light profiling machine. The base is a one-piece casting of heavy section, in which ribs are provided to afford adequate support for all stresses and strains to which the base of the machine is likely to be subjected. This vertical miller is a self-contained machine, being driven by a single pulley two inches in width. Power is taken from the main lineshaft by a belt running over tight and loose pulleys at the left-hand side of the base and transmitted to the driving pulley at the back of the machine. The tight and loose pulleys are protected by guards, and attention is called to the provision that has been made for shifting the belt. This shifting device is entirely enclosed within the guard, and slides on two shafts which keep the shifter in a vertical position. The main driving shaft extends right through the machine and is connected with the spindle driving pulley by bevel gears in which the teeth are cut in a way that assures quiet operation. The spindle driving pulley at the back of the machine is of large diameter, and this pulley is also carefully guarded. An endless belt extends from the spindle driving pulley over two idlers, and thence to a pulley at the top of the spindle. By removing the cover at the back of the spindle driving pulley guard, this belt may be taken off, or replaced, without difficulty. Provision is made for adjusting the idler pulleys to take up stretch in the belt. Where motor drive is required, a special bracket is provided for attachment to the base of the machine. A pulley is mounted on the motor armature spindle, and from this pulley a belt runs directly to the spindle driving pulley.

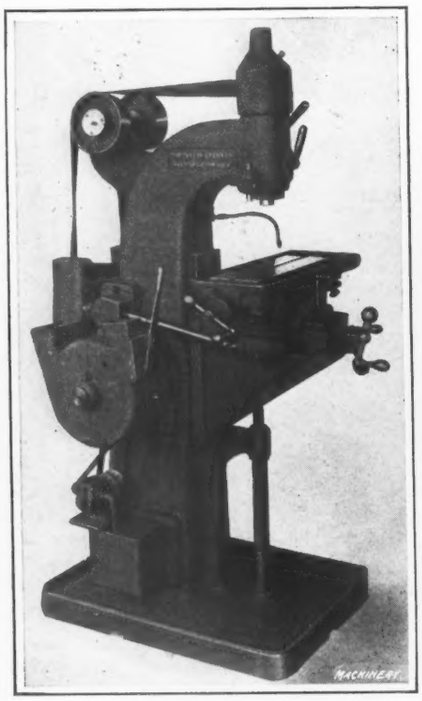


Fig. 1. Left-hand Side of Taylor & Fenn Vertical Milling Machine

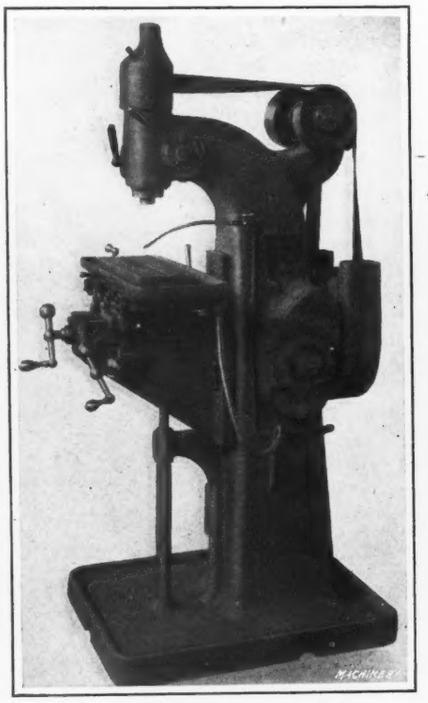


Fig. 2. Right-hand Side of Taylor & Fenn Vertical Milling Machine

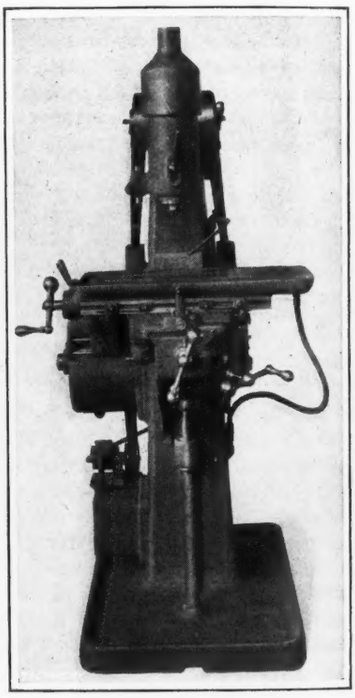
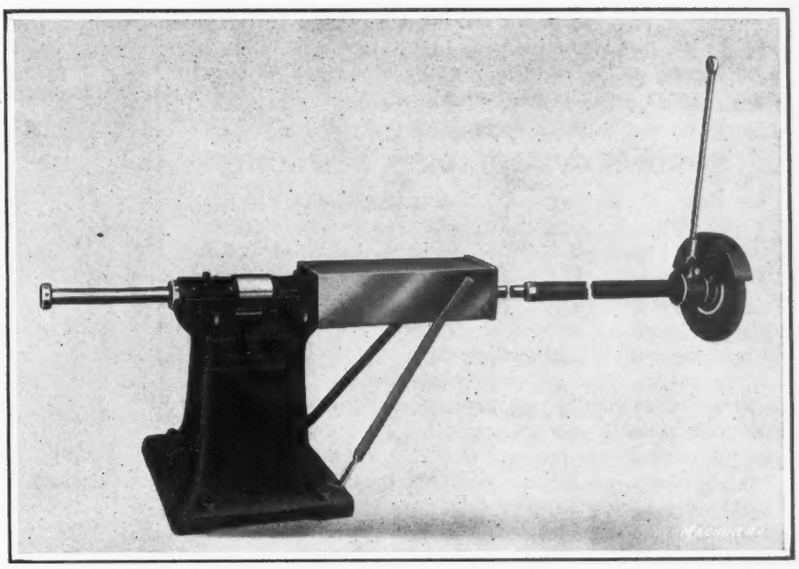


Fig. 3. Front of Taylor & Fenn Vertical Milling Machine

It will be apparent from Fig. 2 that a gear-box has been mounted at the right-hand side of the machine, and by means of the gears in this box, provision has been made for obtaining various spindle speeds and table feeds. Adjustable stops are provided for the cross-feed, and also for the longitudinal power and hand feed. The stops for regulating the longitudinal feed are so designed that when the hand-feed is used it is impossible for the power feed to be engaged. In working out the design of this machine, especial care has been taken to provide convenient means for the lubrication of all bearings. A central reservoir system is provided in the table of the machine, from which oil is fed through copper tubes to important bearings and slides. The coolant pump is a self-contained unit and the tank to which it is attached is located inside of the column of the machine. The whole unit can be quickly removed, and attention is called to the fact that facilities are provided for rapidly filling the tank and for drawing off fluid which is no longer fit for use. A belt runs from the main driving shaft directly to the pump pulley; this belt is endless and it can be quickly removed when necessary. Eleven ball bearings are used in the construction of this milling machine; and owing to their anti-friction properties, very little power is required to run the machine at high spindle speeds. The spindle has a long bearing of large diameter, and it is counterbalanced by a spring, working directly in connection with the rack for moving the spindle up and down. This spring may be so adjusted as to provide for the quick return of the spindle. A positive stop is provided on the quadrant for feeding the cutter down to a specified depth. Double row thrust ball bearings are used on the table screw, and ball thrust bearings are employed on the elevating screw.

The principal dimensions of this machine are as follows: Longitudinal movement, 11 inches; cross movement, 6 inches; vertical movement of knee, 10¼ inches; vertical movement of spindle, 2 inches; maximum distance from end of spindle to top of table, 10¼ inches; distance from center of spindle to face of column, 9 inches; size of working surface of table, 6 by 18 inches; size of T-slots, to accommodate ½-inch clamping bolts; number of available power feeds, 33; range of available power feeds, from 0.0019 to 0.013 inch per revolution of the spindle; number of available spindle speeds, 38; range of available spindle speeds, from 500 to 3100 revolu-

tions per minute; taper of socket in spindle, No. 7 B. & S.; size of hole through spindle, 13/32 inch; diameter of spindle pulley, 4 1/4 inches; width of driving belt, 1 3/4 inch; recommended speed of main driving shaft, 290 revolutions per minute; diameter of tight and loose pulleys, 10 inches; width of driving belt, 2 inches; diameter of large driving pulley for spindle, 20 inches; floor space occupied by machine, 41 by 41 inches; and net weight, approximately 1200 pounds. Equipment furnished with this machine includes a lubricant pump, tank, piping and connections; a spindle driving belt; six change-gears for providing spindle speeds of 500, 850, 1400, and 2200 revolutions per minute; four change-gears for providing table feeds of 0.0027, 0.0039, 0.0053, and 0.0076 inch per revolution of the spindle; and the necessary wrenches for making all adjustments.



Universal Casting Grinder built by the Manhattan Machine & Tool Works

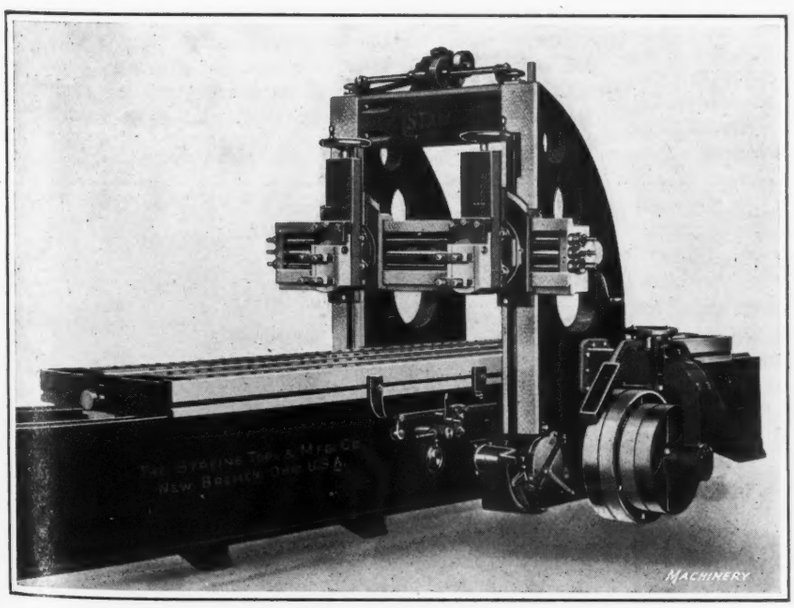
## MANHATTAN UNIVERSAL CASTING GRINDER

In developing a new casting grinder which the Manhattan Machine & Tool Works, 42-50 Market Ave., N. W., Grand Rapids, Mich., have recently placed on the market, the designers have provided a degree of flexibility which adapts this machine for handling a wide range of work. The universal movement of the grinding wheel affords plenty of leeway when working in close quarters, this movement being obtained by a universal coupling and sleeve which give freedom of movement without loss of power. A long handle affords ample leverage for the operator, so that a light touch or a heavy pressure can be applied to the grinding wheel, according to requirements of the different classes of work to be ground. It is also stated that the machine is especially designed to adapt it for use by unskilled labor. Wick oilers and drip-cups provide for the proper lubrication of the bearings.

The machine is usually equipped with a 12-inch grinding wheel which runs at 1600 revolutions per minute, but smaller wheels may be employed, if so desired. Equipment furnished with the grinder includes a countershaft, a counterweight, and two pulleys for the counterweight cable. The longitudinal travel is 12 inches, the length of the swing shaft 7 feet 8 inches, and the shipping weight of the machine, 570 pounds.

## "STAMCO" HEAVY-DUTY PLANER

The Streine Tool & Mfg. Co., New Bremen, Ohio, has developed several sizes of the type of planer that is shown in the accompanying illustration. These machines have been designed along conservative lines and are equipped with roller and ball thrust bearings, extra wide and large V-tracks, large driving gears and pulleys, and large bearing surfaces. The beds are of box type, having a cover plate extending across the entire top except where openings for gears are required. The V-tracks are large and far apart, making a broad-gage heavy-duty bearing. The tables are wide and well ribbed and are provided with ledges to protect the V-tracks from dust and chips. The housings are deep and are of box construction. They are firmly pinned, bolted, and keyed to the beds. The cross-rails are deep and have a large bearing surface for the saddles. The rail screws, rail rods, and rail elevating screws are fitted with ball thrust bearings, and micrometer collars are provided for the rail screws. The rail heads are large and are fitted throughout with tapered gibs. The slide screws also have micrometer collars and ball thrust bearings.



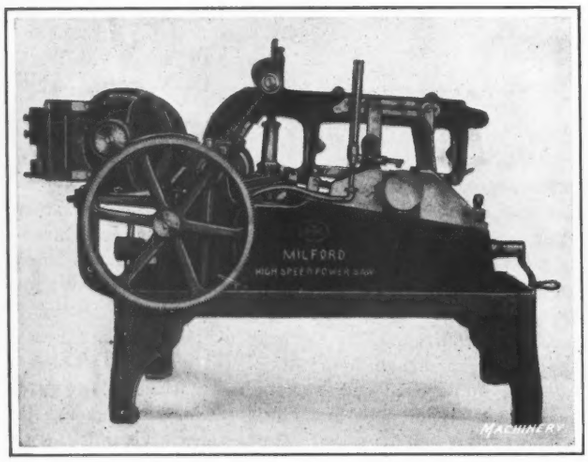
Heavy-duty Planer developed by the Streine Tool & Mfg. Co.

Side-heads may be furnished with the machine and they are of the long-feed heavy type, well counterbalanced and of heavy construction. They are fitted with automatic feeds, and may be run down below the level of the table. The gearing is large and slow-running. The gears are all made of semi-steel, except the main drive pinion which is made of a steel forging. The power elevating device is centrally located on the top brace. It is operated by a clutch and is so designed that it will disengage when coming in contact with an obstruction. The belt shifting mechanism can be operated from both sides of the bed, and the table is provided with dogs on both sides. The belt shifters are adjustable and quick-acting, and a safety locking pin is provided for each shifter. A lubricating system has been provided for all working parts. Additional units, such as extra rail heads, side-heads, special belt and

motor drives, etc., may be furnished with the machine if so desired. These planers are built in the following sizes: 36 by 36 inches; 42 by 36 inches; 42 by 42 inches; 48 by 42 inches; and 48 by 48 inches.

## "MILFORD" POWER HACKSAW MACHINE

The Henry G. Thompson & Son Co., Chapel and Mill Sts., New Haven, Conn., has recently added to its line of power hacksaws a high-speed machine which is described and illustrated herewith. The machine has an adjustable device that grips the saw close to and on both sides of the work so that the work will be cut off straight. It is claimed that the machine will cut mild steel at the rate of 1½ square inch per minute. The guides in which the saw frame slides are arranged so that a rocking motion is imparted to the saw which permits only two or three teeth to cut at the same time and all the pressure is concentrated on these few teeth. A simple mechanical device is provided for lifting the saw off the work on the return stroke. The pressure is applied to the saw blade by means of a spring which is so arranged that the pressure remains constant from the time that the saw begins to cut until it is nearly through the work. An eccentric bolt is provided for fixing the saw blade

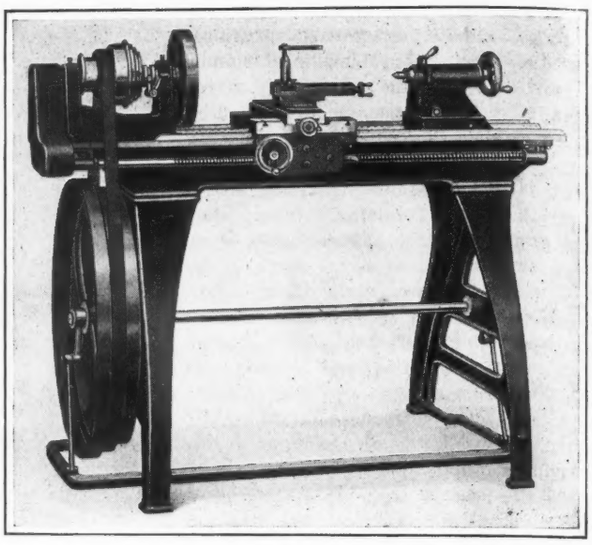



No. 12 "Milford" Power Hacksaw Machine built by the Henry G. Thompson & Son Co.

to the frame, and by giving this bolt a half turn the correct tension is imparted to the blade. A lubricant pump is also provided. This machine may be furnished with pulleys to be belt driven or with a motor for connection with either direct- or alternating-current circuits. A self-starter is supplied with direct-current motors, which is electrically connected to a mechanically controlled knife switch. This self-starter operates to protect the motor at all times from any abnormal starting, and in connection with the trip on the saw machine it automatically shuts down the motor when the cut has been completed.

## "STERLING" FOOT-POWER LATHE

An 11-inch cone-head, back-geared, screw-cutting, foot-power lathe has been lately produced by the Shepard Lathe Co., Canal and Jackson Sts., Cincinnati, Ohio. An illustration of this machine is shown in connection with this description. The headstock contains a heavy hollow spindle which is made of high-carbon spindle steel, and the front bearing is tapered to permit adjustment for wear. The cone pulley has three steps and is suitable for a 1½-inch belt. There is a planetary system of speed reduction inside the cone pulley instead of the usual back-gears. This device permits the spindle to be thrown into direct or back-geared drive by shifting a clutch without stopping the rotation of the spindle. The carriage has a long bearing surface on the bed and a wide bridge, which insures that the carriage will



"Sterling" Foot-power Lathe built by the Shepard Lathe Co.

not tip. A compound or plain rest is furnished at the option of the purchaser, either of which has a large bearing surface. The rests are gibbed throughout and are graduated. The tailstock is of the offset type with a set-over for turning tapers. The tailstock spindle is graduated in sixteenths of an inch to allow for drilling to a certain depth. A power longitudinal feed is furnished as part of the standard equipment, and a graduated power cross-feed is furnished if desired. A chasing dial is arranged in connection with the apron handwheel for use in chasing threads. The foot-treadle enables the operator to drive the lathe from any point along the bed length. Some of the dimensions are as follows: Actual swing over bed, 11¼ inches; distance between centers on a 4-foot bed, 24 inches, and on a 5-foot bed, 36 inches; net weight, 500 pounds; capacity for cutting threads from 3 to 40 per inch.

## "LOGAN" AIR-OPERATED COLLETS

In the April number of MACHINERY a description was published of the "Logan" air-operated chucks, which are made in two-, three-, and four-jaw types, by the Logansport Machine Co., of Logansport, Ind., and sold by the Frank G. Payson Co., of 9 S. Clinton St., Chicago, Ill. In the accompanying illustration there is shown an air-operated compensating collet chuck which is another recent product of this firm, and which is sold by the same agent. These collets are operated by a double-acting air cylinder. The chuck housing or body is made of hardened steel and ground to size, and the tapered seat for the collet jaws is made a part of the housing, which affords a one-piece construction. The

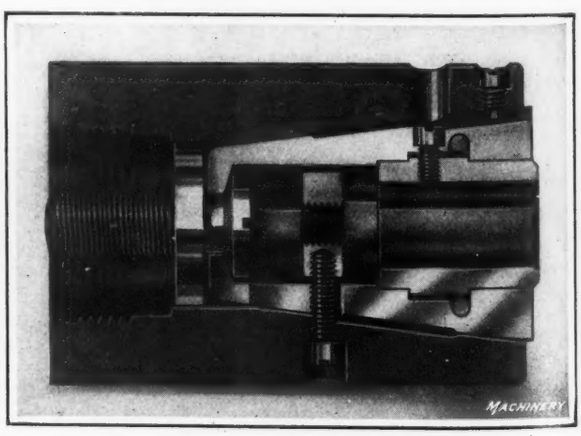



Fig. 1. "Logan" Air-operated Compensating Collet Chuck made by the Logansport Machine Co.

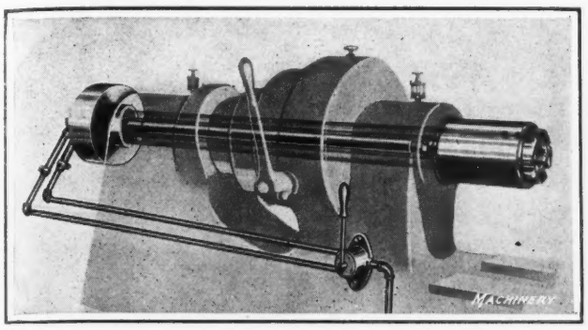
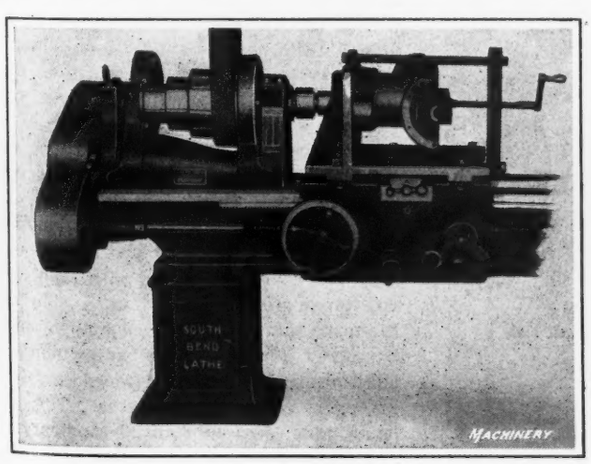


Fig. 2. "Logan" Collet Chuck and Double-acting Air Cylinder applied to a Turret Lathe

jaws are set loosely in the body, and are held in position at the draw-rod end by the tapered head on the draw-rod connecting screw. Springs expand the jaws at the front end. The mounting is such that the jaws are free to adapt themselves to different diameters, and afford an equal and positive grip over the entire length of the work. A travel of ⅝ inch is provided for the jaws when operated on full stroke, and this stroke can be reduced as desired. Drawing the collet back into the long gradual taper affords a powerful grip. These collet chucks are regularly made in two- and three-jaw types, supplied with master collet jaws to which false jaws may be attached for holding various forms of work. They are made in 1½-, 2½-, 4-, and 6-inch sizes.

## CYLINDER BORING ATTACHMENT FOR SOUTH BEND LATHES

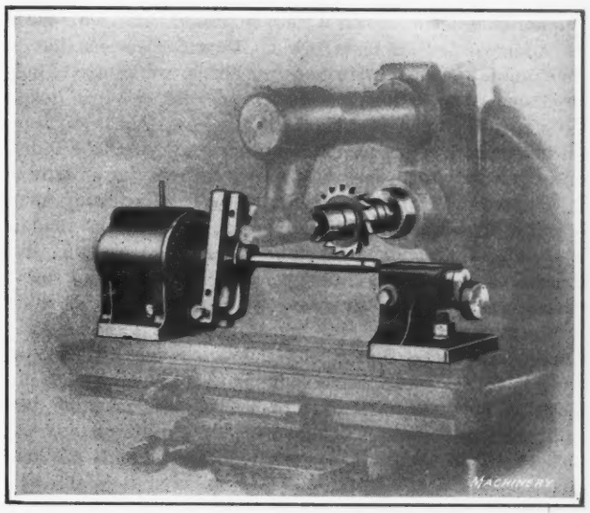
The South Bend Lathe Works, 420 E. Madison St., South Bend, Ind., have recently placed on the market an attachment for reboring automobile cylinders which is applicable to all the 16-inch and larger lathes that have been manufactured by this company. An illustration of the attachment accompanies this description. The device consists of a cast-iron angle fixture and a clamping attachment to secure the work against the vertical wall of this angle fixture, which is fitted to the lathe carriage after the compound rest has been removed, and is located in position by means of two taper pins, after which it is bolted securely to the carriage. A bushing and a plug that is machined to fit snugly into the bore of the cylinder are used to locate the cylinder so that the axis of the bore of the cylinder will be concentric with the axis of the lathe center. After the cylinder has been clamped in position, the bushing and plug are removed before commencing the boring operation. A boring-bar and cutter are also provided. The boring-bar fits into the tapered hole of the lathe spindle, and a special nut is placed on the spindle nose of the lathe for use in removing the bar. The cutting tool will bore holes from 3½ to 4 inches in diameter, and it may be adjusted to 0.001 inch. It is possible to place a collar on the end of the boring-bar to hold a cutter that will bore larger holes. If this fixture is only used occasionally, it is an easy matter to remove it from the lathe and replace the compound rest in order to do regular machine work. The attachment is made in several sizes, the distance from the center of the lathe spindle to the top of the angle fixture base being 4¾, 5⅜, 6½, and 7¾ inches, respectively.




Fixture built by the South Bend Lathe Works for reboring Automobile Cylinders

## BRANDT INDEXING FIXTURE

An indexing fixture that forms the subject of the following description has recently been developed by Brandt & Carpenter, 189 Main St., New Britain, Conn., who have as their selling agents, Meigs & Miller, Inc., 26 Cortlandt St., New York City and 129 Mill St., Rochester, N. Y. While this fixture was designed primarily for use on a hand miller, it may also be used on other milling machines, grinding machines, drilling machines, shapers, planers, and boring mills. It is especially adapted for the quantity production of typewriter and automobile parts, cutters, reamers, etc. The illustration shows work being held in a horizontal position at right angles to the machine spindle. One end of the work is held on the center on the headstock of the indexing fixture by means of a dog, while the other end is supported by the tailstock. The tailstock is made interchangeable with the headstock, so that when several sets are used in one shop, it is unnecessary to maintain matched sets.

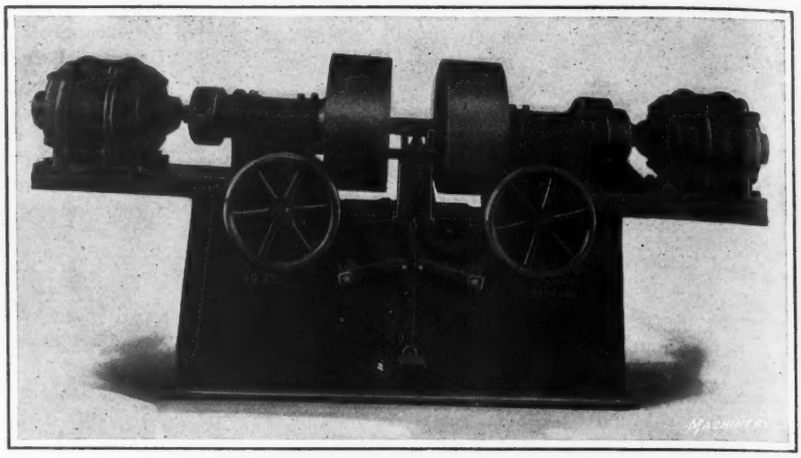


Indexing Fixture and Tailstock made by Brandt & Carpenter

There are other methods of holding work on the fixture that will occur to the experienced mechanic. A drill chuck or a three-jaw chuck may be mounted on the threaded nose of the fixture to be used in place of the dog as shown. The fixture may also be mounted on the machine table so that the work will be held parallel to the machine spindle, or by bolting the indexing fixture to a knee, it is possible to hold work in a vertical position. The base of the fixture may be fitted to angle-plates and angular tables that are also made by the same concern. By means of the angle-plates any single or combination angular setting may be accomplished with precision; and the tables are used for producing tapered work. The manufacturers claim that the fixture will not pass inspection if a height gage shows an error of 0.0005 inch when a test bar is placed between the centers of the headstock and the tailstock.

There is a thrust ball bearing placed between the spindle flange and the headstock of the indexing fixture which eliminates all spindle end play and permits easy indexing from one cut to the next. By raising the lever shown on the top of the headstock, a plunger is disengaged from the index-plate and the plate may be easily turned by hand. This

plunger is actuated by a spring, and as it is tapered, it will be forced into the next hole when the plate is turned. The index-plates are interchangeable, the object being to use a special index-plate having the required number of holes for each quantity job. These plates are furnished in sizes having up to twenty-five holes, which are spaced evenly or unevenly as desired. Some of the important dimensions are as follows: Swing of centers, 7 inches; distance between the centers on a 36-inch slide, 24 inches; height in horizontal position, 5¾ inches; in vertical position, 7¾ inches; and the net weight of this indexing fixture including the headstock and tailstock, 21 pounds.



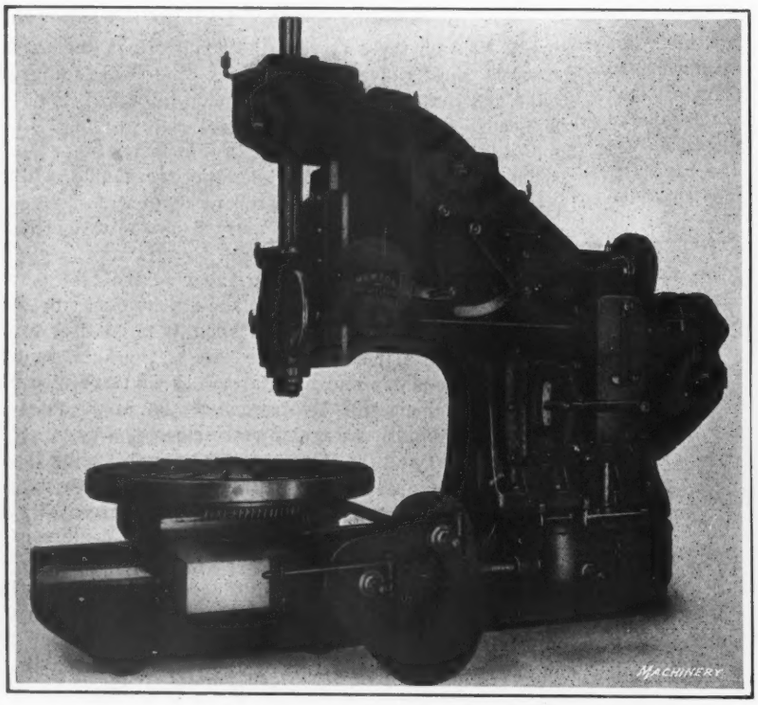
End Surface Grinding Machine built by C. L. Hawes

## HAWES END SURFACE GRINDING MACHINE

The two-wheel end surface grinding machine which is shown in an illustration presented in connection with the following description, is a recent product of C. L. Hawes, 12 Adams St., Ashtabula, Ohio. It will be seen that this machine is equipped with two cup-wheels which are 18 inches in diameter by 6 inches face width, with a 3-inch face on the cup side of the wheel. Each of the wheels is carried by an independent spindle that is direct connected to a 5 horsepower motor which runs at 1200 revolutions per minute and is adapted for connection to a 60-cycle alternating-current circuit. Timken roller bearings are used in the machine, with special provision for lubrication. By pressing down a pedal with one foot, the operator is able to spread the wheels apart so that the work to be ground can be placed in the fixture between the wheels; and when the operator releases the pedal, the wheels come together automatically and grind the work. Provision may be made for grinding pieces from 3 to 12 inches in length, the machine being equipped with stops which provide for obtaining any specified length of work. The work-holding fixture is mechanically oscillated across the face of the grinding wheels to keep them true and to have the end of the work ground square. The machine is arranged so that either wheel can be adjusted independently of the other, to any desired distance from the center position, this adjustment effecting a substantial increase in the range of work which can be ground. Handwheels at the front of the machine are only used in making adjustments. The approximate length of the machine is 9 feet, and it weighs about 2750 pounds.

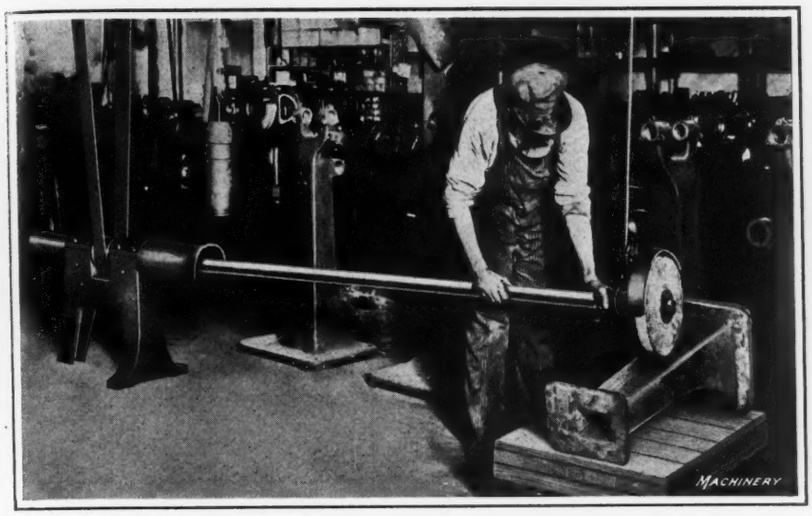
## NEWTON HEAVY-DUTY VERTICAL MILLING MACHINE

A type of heavy-duty milling machine that is extensively used by large locomotive shops and shipbuilders for milling large irregular pieces, and by motor car manufacturers for machining large dies, has lately been remodeled by the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. An illustration of the machine accompanies this description. It is adapted for universal milling requirements, including continuous circular feed operations requiring the use of face milling cutters or circular milling saws, the finishing of surfaces requiring the use of cylindrical cutters, and the finishing or refinishing of holes requiring the use of boring cutters. It has an extensive range of spindle speeds, circular, longitudinal and transverse table feeds, and is provided with vertical spindle saddle feeds. These movements have a reversing fast power traverse and a simple control. The construction of the machine insures accuracy of alignment, the necessary rigidity for duplication of parts, and the elimination of disalignment from operating stresses.



Rugged Vertical Milling Machine built by the Newton Machine Tool Works, Inc.

The spindle revolves in bronze bushings in the spindle saddle and is fitted with a retaining drift-key which is controlled by nuts that are located externally on the spindle nose. The changes of spindle speeds are obtained without the removal of gears, by means of a speed-box, as the speed change-gears are mounted on sliding sleeves which are controlled by levers that are located outside the covers. The spindle saddle is counterweighted, and it has a side adjustment that is maintained by a tapered shoe, and a vertical hand adjustment in addition to the reversing feed and the reversing fast power traverse. The circular table is of substantial construction and has a full bearing on the saddle to which it is secured by corner clamps. The circular rotation of the table is con-




Casting Grinder built by the Grand Rapids Grinding Machine Co.

trolled by an annular bearing having a large diameter and a substantial depth. The table is provided with a reversing feed, a reversing fast power traverse, and a hand control for the circular, longitudinal, and transverse movements, and each movement has an independent clutching mechanism.

The principal dimensions of the machine are as follows: Diameter of table across the working surface, 60 inches; cross-feed of table, 65 inches; in-and-out feed of table, 50 inches; maximum distance from table to under side of frame and vertical spindle, 44¼ inches; vertical traverse of spindle, 24 inches; and distance from center of spindle to frame of machine, 50 inches.

## GRAND RAPIDS CASTING GRINDER

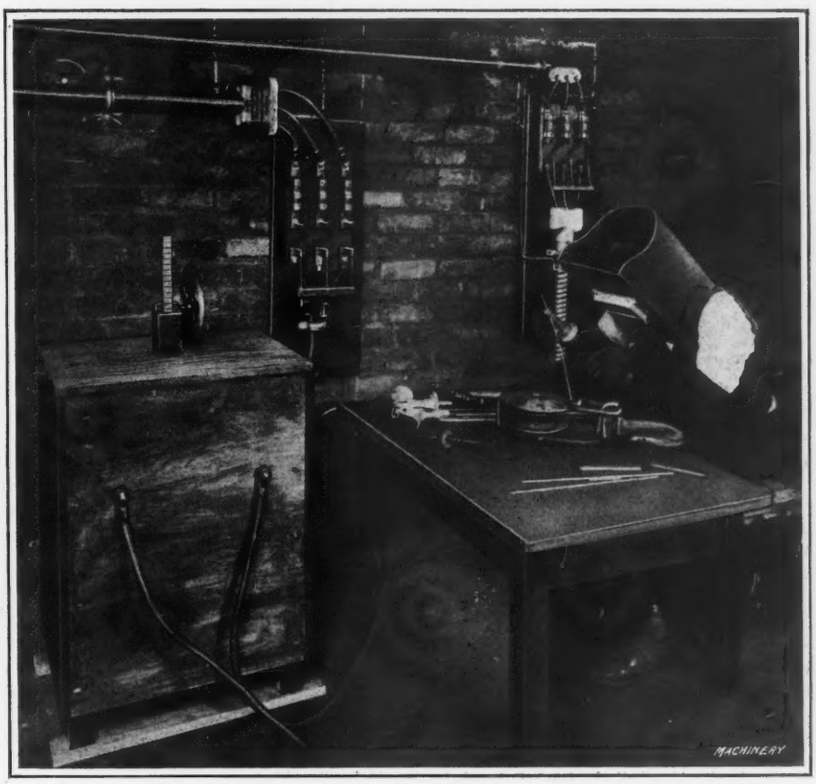
One of the recent products of the Grand Rapids Grinding Machine Co., 29 Ottawa Ave., N. W., Grand Rapids, Mich., is a machine especially designed for grinding castings. In building this grinder, especial attention has been given to the fact that it is to be used by a class of unskilled labor that is likely to subject tools to very heavy usage. For that reason, all parts have been liberally proportioned to withstand severe service. In general, this machine is adapted for grinding all classes of work in the machine shop and foundry, which are of such size that they cannot be conveniently held against the wheel of a grinding stand. Experience has shown that for foundry use in grinding gates, sprues, fins and similar irregularities on castings, and also for what might be called "finish" grinding preparatory to painting, especially on castings where a surface of exceptionally good appearance is required, this casting grinder will be found very useful. The machine is also adapted for such work as grinding steel billets.

The base casting is carried on a three-point bearing which assures a solid foundation when mounted on a rough uneven floor. A ring-oiled type of bearing carries the main spindle, and a reservoir supplies this bearing with oil thus making the bearing construction as nearly fool-proof as possible. The main spindle is made of a hollow steel sleeve with a key extending from the pulley through this steel sleeve into a long feather keyway, in an internal shaft that slides longitudinally in the spindle. To the outer end of this central shaft, there is fitted a heavy universal joint of dustproof construction, which drives a shaft that carries a grinding wheel. From this description, it will be apparent that the wheel is furnished with a swivel action both sidewise and up and down, and it is also free to move in and out, thus covering a considerable area without the necessity of moving the casting.

This machine is furnished with a grinding wheel 12 inches in diameter by 1½ inch face width, which is driven by a 3-inch double belt. All revolving parts are completely protected, and the wheel shaft is enclosed in a pipe over its entire length. To obtain maximum efficiency, the machine should be fitted with a hand-truck type of casting carrier, provided with swiveled casters of large diameter, thus making it possible to move the castings easily and present them to the grinding wheel in the most convenient manner. The standard equipment furnished with this grinder includes a countershaft, counterweight for the wheel, 30 feet of ⅜-inch steel tiller rope for the counterweight, swivel sheave pulleys, clamps for the tiller rope and a grinding wheel guard.

## "ZEUS" ARC WELDING MACHINE

In working out the design of the "Zeus" arc welding machine that has recently been placed on the market by the Gibb Instrument Co., 1644 Woodward Ave., Detroit, Mich., a simple type of transformer has been applied in place of the motor-generator set that is quite commonly used in this class of welding equipment. It is stated that with this new welding machine the consumption of current is exceptionally low. Another important feature claimed for this apparatus is its adaptability for welding cast iron, which is an operation that has given trouble to some users of arc welding machines. The "Zeus" welder is of compact construction,




"Zeus" Arc Welding Machine recently developed by the Gibb Instrument Co.

making it unnecessary to set aside a considerable amount of floor space to accommodate the apparatus; also, this limited size makes it feasible to transport the welder without serious trouble. The machine is built on the unit system so that a 150-ampere equipment may be installed; and should the work become heavier, a duplicate apparatus may be connected in parallel with the original machine. Attention is called to the provision which has been made for regulation. It is not necessary to change connections in regulating the arc. A wheel connected with the secondary coil and extending through the top of the case, raises and lowers this coil and provides for the regulation of the current that is necessary for different sizes of electrodes. The inherent reactance of the welder automatically stabilizes the arc for different arc lengths.

## KANE & ROACH BENDING AND STRAIGHTENING MACHINES

For use in bending rings and cylinders of small diameter out of quite heavy material, Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y., have recently developed a special bending machine which is illustrated in Fig. 1. This machine is made in several sizes to provide for handling work varying considerably in diameter and thickness. The operation to be performed consists of bending work up to a complete circle from end to end, leaving no flat or straight spots. To provide for the performance of such accurate bending operations, and to maintain a true circular form for the work all of the way to the ends, the material must always be bent on the upper or inside roll, which is just the size of the inside diameter of the work, less the spring, or "give back," of the material. For instance, if it is required to bend work with an inside diameter of 3 inches, it would be done on a roll approximately 2⅞ inches in diameter.

The machine is so constructed that the stock is pinched between the upper roll and both of the lower rolls as it passes between them. Without such an arrangement, it would not be possible to make perfect bends from end to end and to maintain an accurate circular cross-section. The upper roll is interchangeable, so that rolls of various diameters may be set up on the machine to conform with the inside diameter of the work. A little thought will make it apparent, however, that the range of work that can be handled with any one machine is limited. It may be found possible to handle work over a range of 1 inch in inside diameter on a given machine, and on very large work, a variation up to 1½ inch in diameter is not found to constitute an insurmountable difficulty. When it is attempted to exceed the limits of variation which have been mentioned, it is still possible to bend work, but the machine fails to produce a true circular cross-section.

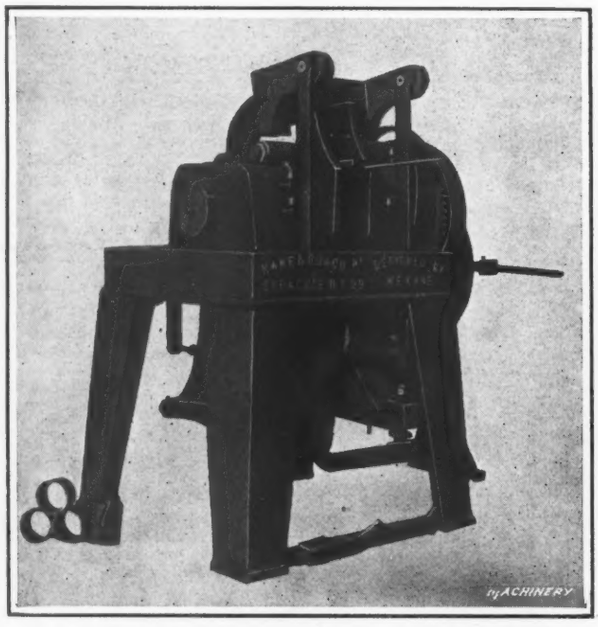



Fig. 1. Machine built by Kane & Roach for Use in bending Rings and Cylinders

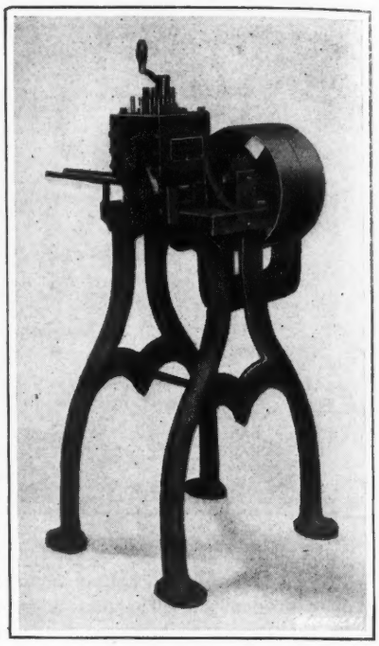


Fig. 2. No. 00 Straightening Machine built by Kane & Roach

Both the upper and lower rolls are supported on both ends so that there is no chance for lost motion to develop or for the rolls to be sprung out of alignment. All three of the rolls are driven by power so that the stock is positively driven through the rolls on the machine without any tendency for it to slip. Where it is feasible, the rolls should be corrugated and hardened. If the work must be perfectly smooth on the inside, the two lower rolls that engage the outside of the work may be corrugated to provide for drawing the material through the machine. In cases where it is not of vital importance to have the inside of the work smooth, but where the outer surface must be smooth, then the upper roll that engages the inside of the work is corrugated and hardened to provide for drawing the material through the machine, and the two lower rolls are left smooth. Hardening the rolls is for the obvious reason of giving them plenty of strength and durability. The machine is so constructed that it is possible to instantly release the upper roll, so that it may be raised; also, the bearing for this roll may be released to provide for pushing the cylindrical work off the roll when it is finished. Adjustment is provided for positioning the upper roll for different thicknesses of work, and also to afford compensation for wear.

The material to be bent is placed on a small plate which has a handle attached to it, and guide plates on each side, which so restrain the movement of the work that it cannot enter the machine in a crooked position. An alternate method is to lay the piece to be bent on this plate and then tip the plate to provide for feeding the work into the machine. This latter method does away with danger of the operator getting his hands between the bending rolls. This machine is provided with a clutch pulley to provide for starting and stopping. On the floor beside the machine there will be seen a small pile of roller bearing casings which are made of high-carbon cold-rolled steel ⅛ inch in thickness by 4 inches in width. These are bent into circles 3 inches in diameter. In bending, the parts are left with a gap 3/16 inch wide to give them plenty of strength, so that the casings may be pushed into the bearing and hold themselves in place. It is claimed that the machine bends these casings smooth and true enough so that they may be put right into the bearing and used, without requiring any subsequent machine work. Machines of this type are built to provide for bending circular work as small as 2 inches in diameter, and the capacity ranges from that size up to practically any diameter.

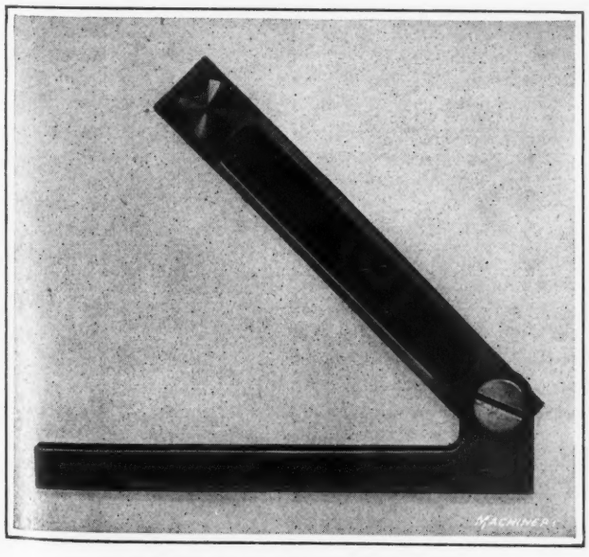
### No. OO Straightener

Fig. 2 shows a No. 00 straightening machine which is another recent product of Kane & Roach. It is stated that

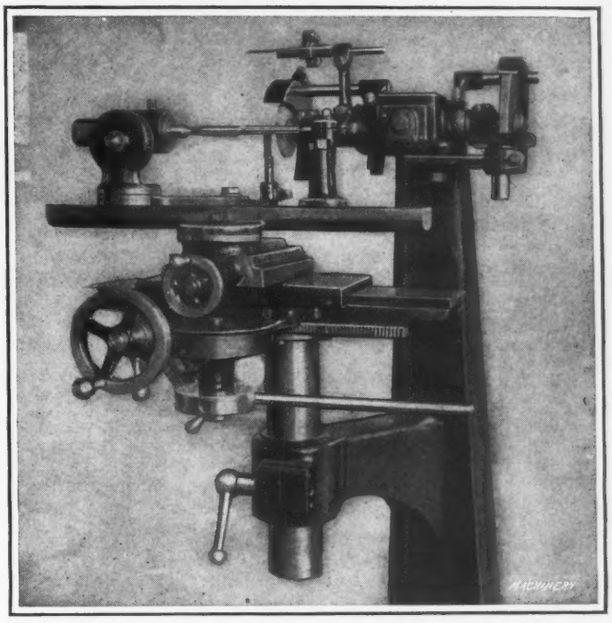
this is one of the smallest sized metal straightening machines which has ever been built for the market. The rolls are only spaced 1 1/8 inch from center to center, and they are 1 3/32 inch in diameter by 2 inches in length. These rolls are supported by bearings at both ends and there are eight rolls—four upper and four lower—just the same as in larger sizes of straightening machines built by this company. Gages are provided which indicate exactly where to adjust each roll, and also whether all of the rolls are in accurate alignment. These gages also indicate where the rolls should be located for handling different classes of work. Two of the upper rolls are driven by gears, as well as all four of the lower rolls. This machine is furnished with cut gears and the rolls run at from 300 to 350 revolutions per minute, according to the class of work on which the machine is engaged. This outfit is especially designed for straightening short pieces of work after they have been cut into pieces required for subsequent manufacturing operations, and more especially material where it is necessary to accurately straighten the piece practically all of the way to the end. Pieces of small diameter, such as wire, may be straightened regardless of whether the material is received in the form of bars or coils. Rolls can be made with any form of passes to take the work, provided that it comes within the capacity of the machine.

## SIMPLEX SINE BAR

To meet the demand for a tool which will accurately measure angles and also be readily and quickly adjusted, the Simplex Tool Co., Woonsocket, R. I., has placed on the market an improved sine bar. This tool is made for accurately measuring angles with the use of a table of sines, and it enables the user to measure an angle to within a few seconds, by simply finding the sine of the angle to be measured, multiplying by five, and adding the constant, which is stamped plainly on the tool; he then swings down the arm which carries the button until the measurement is obtained either by the use of micrometers, measuring over the base, or by using gage-blocks directly from the top of the base and tightening the locking mechanism. Gage-blocks for setting common angles without figuring will be furnished if desired, and when so ordered, the sine bar and blocks will be fitted into a hard wood box. Advantages claimed for this sine bar are as follows: That there is only one dimension to set, due to the fact that the bar itself is mounted on a base. That the construction is such that it can be used against an angle-plate or laid flat upon its side which is absolutely flat. That some classes of small work can be clamped directly to the bar, owing to its channel construction. The clamping device for the bar is an entirely new method which locks the bar to the base with a very powerful and centralized grip, and the same time there is absolutely no tendency to spring or move the setting of the bar in the least. A special grade of steel is used for making this tool, which possesses non-changing qualities, and the tool is hardened and ground all over.



Sine Bar made by the Simplex Tool Co.



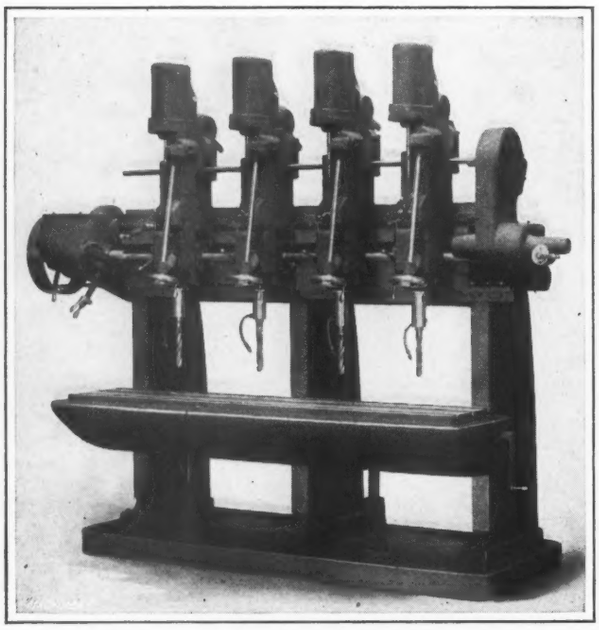
Tool and Cutter Grinding Machine built by the Thompson Grinder Co.

## THOMPSON TOOL AND CUTTER GRINDER

The Thompson Grinder Co., Springfield, Ohio, has recently redesigned its universal tool and cutter grinder, and among other changes, a two-speed mechanism for the longitudinal travel of the table has been incorporated in the design. This is a distinct improvement over the one-speed arrangement that was formerly used. For traversing the table forward and backward on the slow speed, the large handwheel at the front of the machine is used. On the other end of the shaft that carries this wheel, there is a worm meshing with a large spur gear which, in turn, meshes with a rack that is made an integral part of the ways on which the table lies. The quick action is obtained by movement of the lever that is attached directly to the end of the shaft on which is carried the large spur gear. Before it is possible to operate from this lever, the worm previously mentioned must be disengaged. This is easily accomplished by turning the small handle shown behind the handwheel, which operates an eccentric bushing and throws the worm out of mesh. Aside from the features just described, the Thompson universal tool and cutter grinder is built along the same lines as machines formerly manufactured by this company, which were illustrated and described in the August, 1918 number of MACHINERY.

## DEFIANCE RAIL DRILLING MACHINE

A No. 23 rail type of drilling machine, which is shown in the accompanying illustration, is a recent product of the Defiance Machine Works, Defiance, Ohio. This is a heavy-duty production machine, and although it is especially intended for use in locomotive and railway shops, gas-engine, and automobile factories, etc., it will be found well adapted for installation in general machine shops, where the range of work includes heavy gang drilling or jigged drilling. When used on jigged work, the compactness of this machine enables one operator to keep a number of spindles employed, either singly or in groups, and not only are the spindles kept at work, but the operator is also constantly employed unloading and reloading the jigs. The speed mechanism,



Rail Type of Drilling Machine built by the Defiance Machine Works

feed mechanism, and each spindle head are of unit construction, and each unit is readily accessible without disturbing the mechanism of other units.

The speed mechanism is attached at the top of the upright at the left-hand end of the frame. It consists of two cones of hardened steel gears, back-gears, and a hardened roll-in gear. There are three gears on each of the cones which provide three sets of gears of different ratio; and when used in conjunction with the back-gears, these three sets of gears afford six speed changes which are selected by sliding and dropping the roll-in gear into mesh with the various sets of gears on the cones. Hyatt roller bearings carry the shafts in the speed-box, and the driving shaft which transmits power from the speed mechanism to the spindle runs in ball-bearings. A Johnson friction clutch transmits power to the speed-box from a single pulley.

The feed mechanism is contained in a case fastened to the top of the upright at the right-hand end of the frame. Two cones of gears driven by the spindle driving shaft provide the feed changes. Each of these two cones is fitted with three gears of different ratios, giving three changes of feed for each spindle speed. Changes of feed are effected by a sliding key mechanism operated by an index hand-lever. The feed is transmitted from the two cones of gears to the feed-shaft through bevel gears and a worm and wheel, the end thrust being supported by ball bearings. A wheel is provided for quickly advancing or returning each spindle.

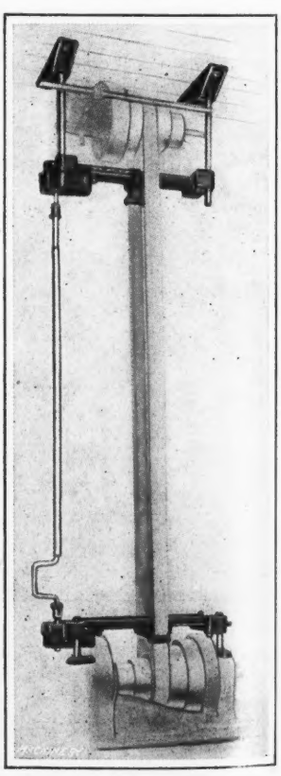
The spindle heads are gibbed to a heavy cross-rail, and each head is a self-contained unit, adjustment along the rail being accomplished by means of a crank handle that operates a rack and pinion mechanism. The spindles are made from high-carbon steel forgings, and they are driven by spiral gears with two keys extending from the gear through the sleeve and into keyways in the spindle. The end thrust is supported by ball bearings; and by locating the drive at the lower end of the head, the torsional strain is reduced to a minimum. Each spindle is counterbalanced and can be driven and fed independently of the other spindles. Interlocking levers are furnished to apply the feed and drive to each spindle, so that the power feed cannot be engaged when the spindle is not being driven. The feed is automatically disengaged when the hole is drilled to a specified depth.

Vertical adjustment of the table is accomplished by means of a crank which actuates two jack-screws through a worm and wheel mechanism. These screws support the table and maintain its original true alignment by receiving the thrust of the cutting tools on a direct center line with the spindles. A cored section of the table surface affords a reservoir for cutting compound, and the table casting is shaped on all four sides to form a trough in which the cutting compound flows back to the reservoir. The pump which forces the coolant to the work is fastened to the upright at the left-hand end of the frame, and is driven direct from the countershaft. A combination forced-feed, gravity-flow and splash system is employed for oiling, this design being made possible by the enclosed unit construction that has been employed. The speed mechanism, feed mechanism, and each of the spindle heads, are provided with independent self-contained oiling systems, which eliminate the human factor in caring for the machine, and assure positive lubrication and economical maintenance. The mechanism in each unit is partially submerged in a bath of oil, while the bearings are lubricated by a forced feed through individual leads.

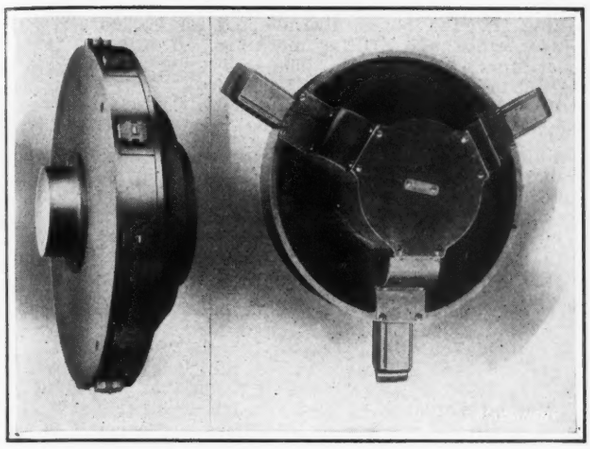
The principal dimensions of this machine are as follows: Capacity for drilling steel, up to 2 inches; maximum distance from nose of spindle to top of table, 32 inches; distance from center of spindle to face of column, 12.26 inches; maximum distance from center to center of spindles, 8 inches; maximum distance from center to center of outside spindles, 78 inches; maximum power feed, 12 inches; size of working surface of table, 20 by 98 inches; maximum vertical adjustment of table, 12 inches; available rates of spindle speed, 25, 38, 58, 80, 122, and 186 revolutions per minute; available rates of feed, 0.006, 0.009, and 0.014 inch per revolution of the spindle; diameter of spindle nose, 3 inches; diameter of spindle at driving point, 3 inches; diameter of spindle sleeve, 4 inches; taper of socket in spindle, No. 5 Morse; size of driving pulley, 20 inches in diameter by 5¼ inches face width; speed of driven pulley, 350 revolutions per minute; power required to drive machine, 10 horsepower; floor space occupied, 56 by 144 inches; and net weight of machine, 12,180 pounds.

## "SAFSHIFT" BELT SHIFTER

An attachment for shifting belts has been placed on the market by the Artisan Mfg. Co., Lockland, Ohio. It was designed primarily to protect operators from injuries which frequently result from shifting belts on step cone pulleys by hand. The attachment is shown in the accompanying illustration and consists of duplicate upper and lower units which are connected by a crankshaft, one turn of which moves a belt carrier on each unit along a steel guide a distance equal to the width of the belt. The crankshaft is connected to a mechanism in the grease-tight boxes at the left end of each of the guides, by means of which an intermittent movement is given to the carriers which control the belt. The construction is such that a single size of the device can be arranged to accommodate different numbers of steps on the pulley and different widths of belts. The lower guide is held by two one-inch steel posts which are secured by clamps to the machine to which the device is attached. The upper guide is likewise secured to two posts which extend downward from brackets fastened to the countershaft support.



Attachment for shifting Belts, made by the Artisan Mfg. Co.



Twelve- and Three-jaw Chucks made by the American Pneumatic Chuck Co.

## AMERICAN AIR-OPERATED CHUCKS

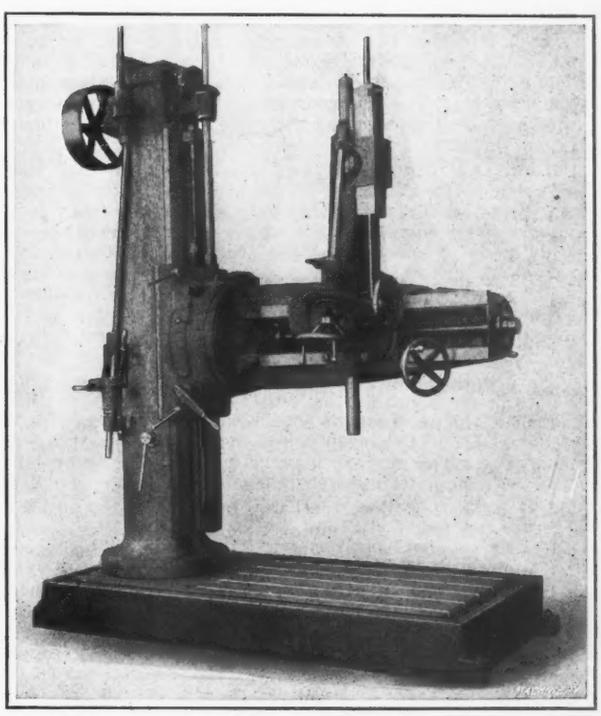
The illustration shows two types of air-operated chucks that have been developed by the American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill., for use in connection with the manufacture of rubber tires. The chuck shown at the left has twelve jaws and was designed to hold solid rubber tires from 28 to 36 inches in diameter, the jaws having a movement of over 4 inches. The twelve jaws are necessary to prevent forcing the tires out of shape. The movements of the jaws are obtained by means of racks and pinions. The working parts of the chuck are enclosed, which protects them from dirt and avoids injury to the workman. The chuck is made 3½ inches wide along the outside diameter so as to adapt it for narrow tires. It is operated by a 12-inch double-acting air cylinder. External gripping may be accomplished by using false jaws.

The three-jaw chuck shown at the right in the illustration is used in connection with pneumatic rubber tires. The jaws have a range of from 17 to 24 inches in diameter. The interior construction of this chuck is similar to that of the twelve-jaw chuck. It is operated by a 10-inch double-acting air cylinder. The Neidow & Payson Co., 9 S. Clinton St., Chicago, Ill., is the selling agent for the American Pneumatic Chuck Co.'s products.

## WESTERN UNIVERSAL RADIAL DRILLING MACHINE

The universal radial drilling machine that is shown in the accompanying illustration is built in 4-, 5-, and 6-foot sizes by the Western Machine Tool Works, Holland, Mich., and is especially suitable for rapid drilling and tapping. The illustration shows the machine with some of the gear guards removed. The column, which has a box section, revolves around an inner column that is bolted to the bed, thus permitting the arm of the machine to be swung to any desired position for drilling. By means of binding handles, the outer column may be clamped to the inner one, thus making them practically one piece. The bed is provided with T-slots for bolting down the work or the jigs that are being used. The gear-box on the top of the column is provided with eight changes of speed. These speed changes are accomplished by means of hand-levers and connections at the front side of the column. By means of back-gears eight more speed changes are obtained. The arm saddle is provided with an adjustable gib for taking up wear on the edges of the column. Binding handles are used to clamp this saddle in position on the column. The arm elevating mechanism is located in the arm saddle and is controlled by a lever on the front side of the saddle. The reverse motion for raising or lowering the arm is transmitted through a pair of adjustable friction clutches. The inner end of the arm is graduated in degrees and it may be swiveled through a complete circle by means of a worm and worm-gear. Four T-bolts are provided for binding it to the saddle and a dowel locates it in a zero position.

Tapping is accomplished by means of a pair of bevel friction gears mounted on the vertical drive-shaft in the arm saddle. Internal expanding ring frictions with adjustments for wear, which have a capacity for the full load of the machine, are provided for controlling the forward and backward motion of the spindle. The spindle head may be swiveled a total of 90 degrees by means of a segment gear and pinion, or through a full circle when swiveled by hand. The swiveling of the head is independent of the head saddle moving mechanism, and suitable means are provided for locking it in place. The head saddle is moved longitudinally by means of a handwheel and is provided with a tapered gib to take up wear. A feature of the machine is that the spindle is driven by a pair of gears at its lower end, close to the drill or cutter that is being used. There are four feed changes from 0.006 to 0.018 inch per revolution of the spindle. The feed of the drill may be disengaged by hand or by an automatic depth gage which can be set to trip at any point desired. The power feed is tripped when the spindle reaches its limit of travel in either direction, in such a way that the worm remains constantly in mesh with the worm-gear. The small handwheel located at the right-hand side of the head furnishes means for feeding the spindle by hand when desired. The friction clutch ring is expanded by means of a pair of adjustable fulcrum friction fingers which are operated by a handle. When the friction is disengaged either by the automatic trip or by hand, the spindle may be raised or lowered by means of the handwheel. When the machine is equipped with a motor drive the motor is placed on a plate which is bolted to the rear of the column. The gear-box on top of the column gives the necessary speed changes, provided a constant-speed motor is used. In case a variable-speed motor is used, the gear-box may be replaced by a casting having suitable bearings for supporting the driving shaft, or the motor can be mounted on top of the column and geared directly to the vertical drive-shaft. Attention is drawn to the fact that the guards have been removed from the gearing on this machine in order to show the mechanism; but all gears and other rotating parts are fully protected to provide for the operator's safety.



Radial Drilling Machine built by the Western Machine Tool Works

## NEW MACHINERY AND TOOLS NOTES

**Fiber Vise Jaws:** Henry Frey, 337 Gould Ave., Pittsburg, Pa. Each jaw consists of a galvanized iron pocket that fits over the jaw, and a fiber inset that may be replaced when worn or may be removed to insert some softer material when it is desired to hold very delicate work.

**Jack:** Harvard Machine Co., Harvard Square, Cambridge, Mass. A small jack known as the "Hi-Lo" which may be adjusted from 2 to 4 inches. The parts are made of steel and are hardened. The top piece is held in position but is capable of adjusting itself to uneven surfaces.

**Oxy-acetylene Cutting and Welding Tips:** Alexander Milburn Co., Baltimore, Md. The special feature of these tips is that the same torch may be used for both cutting and welding operations by simply changing the tip. It is also claimed that the cutting tip may be burned considerably before the cutting qualities of the flame are impaired.

**Plier Wrenches:** A. C. Allen, 6441 Eggleston Ave., Chicago, Ill. A line of plier wrenches having different types of jaws which are always parallel. They may be adjusted for three sizes of openings through a slot in which the fulcrum pin is held. By releasing the handle and taking a new grip, a ratchet motion is possible for turning nuts or pipes.

**Storage Battery Charging Outfit:** Hobart Bros. Co., Troy, Ohio. This storage battery outfit was especially designed for charging the storage batteries of industrial tractors and of automobiles, but it can also be used for electric lighting purposes. It may be operated from a lineshaft or engine. The outfit includes a generator, base tracks, field rheostat, charging panel, and pulley.

**Indicating Caliper:** F. W. Horstmann Co., 210 Coit St., Irvington, N. J. An indicating caliper that may be used to a limited extent as a snap gage. This caliper will gage work that is within 1/32 inch of the correct size. It has a dial that indicates the variation in the size of the work in thousandths of an inch. It is made in various sizes to measure from 1 inch to 12 inches.

**Geared Pumps:** Matson Machine Co., 2 Beacon St., Concord, N. H. Two new types of geared pumps that have valves which cause the liquid to flow in one direction regardless of the direction in which the machine is running. They are made for ¼- and ⅜-inch pipe connections. One style has an adjustable base that can be set at any angle necessary to bolt the pump to a machine.

**Inserted-tooth Milling Cutters:** Gale-Sawyer Co., 36 Oliver St., Boston, Mass. A type of inserted-tooth cutter which has the blades held in position in such a manner that they cannot loosen or change their position when the cutter is being used. It is claimed that the cutter will not jam on the arbor due to heavy work and the harder the cutter is driven the tighter the blades will become.

**Worm-gear Hobbing Machine:** Cone Automatic Machine Co., Inc., Windsor, Vt. A machine that has been produced for hobbing large quantities of worm-gears up to 18 inches in diameter, but that is adapted for handling larger gears in emergency cases. The gear blank is secured to the upper end of a vertical spindle and the cutter is fed into the blank, this motion being limited by stops.

**Portable Air Outfit:** Hartford Machine Screw Co., Hartford, Conn. A modification of the portable air outfit known as the "Master." It is suitable for cleaning machined parts, having a ½-horsepower motor which may be run by a connection made to an electric light socket. The equipment is mounted on a metal truck but a stationary type is also made. The bore of the pump cylinder is 1¾ inch; the stroke of the piston is 2 inches.

**Grinding Stand:** Janette Mfg. Co., 617-631 W. Jackson Blvd., Chicago, Ill., and 149 Broadway, New York City. An electric grinding stand furnished in bench and floor types. It is made for operation on either 110 or 220 volts direct current and has a speed of 3500 revolutions per minute, or for operation on 110 or 220 volts alternating current, 30, 50, or 60 cycles. The current may be supplied from any lamp socket. A push-button switch is located on the grinder base.

**Marking Tool:** Helios Metal Co., Inc., 437 11th Ave., New York City. A tool for stamping numbers and letters, which consists of a small wheel and a holder. The number and letter stamps are carried on projections of the wheel, which can be easily turned or held in place by means of a spring that presses a pin into holes on the side of the wheel. One holder is furnished with four wheels; one wheel carries numbers from 0 to 9, and the others have all the letters of the alphabet.

**Offset Boring Head:** Detroit Pattern Works, Detroit, Mich. An offset boring head that has a travel of 2 inches, allowing a 4-inch hole to be bored. It was developed for use on a milling machine, but is also adapted for use on screw machines, lathes, and drilling machines. It is bored to fit a No. 4 Morse taper shank. The lead-screw is graduated on one end to show movements of 0.001 inch. This boring head is distributed by the Great Lakes Sales Co., 924 Dime Bank Bldg., Detroit, Mich.

**Milling Machine Vise:** F. C. Sanford Mfg. Co., Bridgeport, Conn. A quick-acting cam vise that is operated without tools. The movable jaw is moved forward and backward by means of a screw and handwheel, and the work is clamped by means of a hand-operated cam-lever. The jaw can easily be changed. A heavy-duty milling machine vise is also built by this concern, which is suitable for heavy work on triple back-geared milling machines. It is made with either a 4-inch or a 9-inch opening.

**Combined Truck and Tractor:** Clark Tructractor Co., 80 E. Jackson Blvd., Chicago, Ill. A vehicle that is known as the "Tructractor." The claim is made that a load of 1½ ton may be carried when used as a truck and that it is capable of hauling a number of loaded trailers when it is used as a tractor. It has a four-cylinder motor with an internal gear-driven axle, and a standard automobile control. The operating speed may be varied from one to fifteen miles per hour. The weight is 2050 pounds.

**Portable Paint Spraying Machine:** International Engineering Corporation, Malden, Mass. A type of spraying apparatus that may be used for painting freight cars on the track, buildings, ships, fences, or bridges, as it is mounted on a truck and may be easily transported to the necessary place. The air is supplied by a compressor that is run by a small gasoline engine, but it can be furnished with an electric motor for this purpose if the equipment is to be used in the vicinity of power connections.

**Drill Chuck:** American Machine Co., 104 Wellington Ave., Hartford, Conn. This chuck is known by the trade name of "Ellison." It is made in various sizes for holding drills up to 1 7/32 inch, and several more sizes having a capacity up to 7/8 inch will be placed on the market shortly. The chuck jaws are tightened by means of a wrench which has steel pinion teeth that mesh with teeth cut on the lower end of the sleeve. The end of the wrench is placed in steel bushed holes when being used for this purpose.

**Electric Drying Oven:** General Electric Co., Schenectady, N. Y. A portable electric oven that has been developed in order to reduce the cost of handling small parts that are to be japanned or enameled. There are four heating units, and four heats are obtained by means of snap switches. After the work is heated to the desired temperature, the heat may be regulated by means of these switches. Ventilation has been provided for the oven, since the work for which the oven has been developed requires air for proper drying.

**Elevating Truck:** Lewis-Shepard Co., 48 Binford St., Boston, Mass. A light-duty elevating truck known as the "Type M Singlelift," which is intended for carrying loads up to 2000 pounds. When it is desired to raise the load, a foot-pedal is pressed forward to engage the lifting handle with the load. A feature is that the load cannot be lowered unless the operator has his hand on the handle in order to control its descent. The handle can always be turned for starting purposes. This truck is made in nine styles with platforms varying from 28 to 48 inches in length.

**Pneumatic Tools:** Keller Pneumatic Tool Co., Grand Haven, Mich. Two pneumatic tools—a drill and a chipping hammer. In the drill the usual valve mechanism has been eliminated, thus, it is claimed, reducing the air consumption, the maintenance cost, and adapting the tool for heavy service. The feature of the chipping hammer is that the handle is locked to the cylinder in a compact manner which permits the tool to be used in places where there is little room for working. This hammer is made in ten sizes having strokes ranging from 1¼ inch to 4 inches.

**Grinding Wheel Radius Former:** W. T. Smith Mfg. Co., Bridgeport, Conn. A grinding wheel dresser known as a universal radius former which is used to give the proper form of wheel for grinding formed work. The important feature is that a trunnion yoke holds a diamond-holder. The exact radius to which the wheel is being dressed may be ascertained by means of a micrometer adjustment on the handle. This micrometer is graduated in thousandths of an inch for radii from 0.030 inch to 3.5 inches. It is so constructed that the diamond-holder never projects more than ½ inch from its support.

**Combination Disk and Emery Wheel Grinding Machine:** United States Electrical Tool Co., Cincinnati, Ohio. This machine is built in one- and two-horsepower types, and is furnished with either direct- or alternating-current motors. It has a speed of 2000 revolutions per minute when direct current is used and 1700 revolutions per minute when al-

ternating current is used. On the one-horsepower machine the wheel is 10 inches in diameter and the disk 12 inches in diameter. On the two-horsepower machine the wheel is 12 inches in diameter with a 1¼-inch face, and the disk is 12 inches in diameter.

**Dynamic Balancing Machine:** Crawford Tool & Mfg. Co., 1617 S. Crawford Ave., Chicago, Ill. A machine that is suitable for use on flywheels, pulleys, gear wheels, turbine rotors, connecting-rods, propellers, fans, separator disks, and other machine members that are to be put into dynamic balance. The weight of the counterbalance that must be added is indicated by a vibration indicator. It is claimed that the machine will show the vibration caused by a weight of ⅛ ounce placed on a radius of 5 inches when the machine is revolving at 900 revolutions per minute. It is adapted for parts from 4 to 36 inches in diameter weighing up to 500 pounds.

**Vertical Milling Machine:** Becker Milling Machine Co., Hyde Park, Boston, Mass. A milling machine that is believed to be the largest and heaviest miller of this type that is at present on the market. It has many of the features that are contained in the other machines built by this firm. The centralized control allows the operator to manipulate the hand and power feeds from a position in front of the machine. Some of the main dimensions are as follows: Longitudinal feed of table, 79 inches; cross-feed of table, 20 inches; over-all working surface of table, 20 by 110 inches; maximum distance between spindle and main table, 22 inches.

**Open-side Planers:** Cincinnati Planer Co., Cincinnati, Ohio. A new type of machine that has the same characteristics as the double-housing planer of this company's manufacture. It is built in three sizes: 36 by 36 inches; 48 by 48 inches; and 72 by 72 inches. The 36- and 48-inch machines are provided with two cutting speeds and a constant speed return, but either a reversible or non-reversible direct-current motor drive is furnished when a greater number of speeds are required. The operator can control the motion of the table by means of shifting levers at both the front and rear of the machine. It has a speed device that prevents the table from starting unless so desired by the operator.

* * *

## FOREIGN TRADE NOTES

Recent modifications of the list of prohibited imports into Great Britain are of particular interest to the metal trades. The following are some of the articles upon which all restrictions have been removed: Bolts and nuts; wood-screws; machine tools and parts; abrasive wheels; adjustable clamps; anvils; auger bits; bench drills; boring heads; calipers; chasers; chucks; dies and die-stocks; die-heads; drills; drill sleeves and sockets; emery wheel dressers; hacksaw blades; lathe dogs; lead hammers; machine vises; verniers; micrometers; milling cutters; pipe cutters; pipe vises; pipe wrenches; punches; reamers; saws; thread milling cutters; tapping attachments; taps; tap wrenches; tool-holders; and woodworking machinery. Ball bearings, roller bearings, ball retainers, ball bearing bolts, and steel balls may be imported under special licenses.

### Imports of Automobiles into Great Britain

The War Trade Board announces that the Controller of Import Restrictions of Great Britain has issued notice that British import licenses will be issued admitting into Great Britain automobiles up to 50 per cent of the number imported during 1913, until September 1. Each importer must apply for an individual license and submit a statement as to his imports during 1913. Under this ruling, the term "automobile" covers motor vehicles of all kinds, including motorcycles and accessories. Further inquiries may be addressed to the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

### British National Industrial Council

A recent conference of the British employers' associations and the trade unions has approved of a plan for the formation of a National Industrial Council, the duties of which shall be to establish an industrial parliament to discuss all questions of difficulty or disputes arising in the future between employers and employes; to agree as to a minimum rate of wages in all industries; to fix the standard working hours and the conditions of service; and to act as an expert advisory body to the Government in all proposals for legislation affecting industry.

### Facilitating Trade with France

In order to facilitate and promote trade between France and the United States, an alliance of French and American banking interests, combining resources of over $1,250,000,000, has been organized, the French participant in the alliance being the Comptoir National d'Escompte de Paris, and the American interests represented being the First National Bank of Boston and the National Bank of Commerce, in New York. The name of the new organization is the French-American Banking Corporation. It will engage in the acceptance business and, in general, will assist in financing trade between the United States and France.

### Removed Trade Restrictions

The War Trade Board announces that the free list of exports for Denmark, Norway, Sweden, Holland, Switzerland, Finland, Luxemburg, and the occupied Rhine territory has been amended to include machinery of all kinds and parts (except textile machinery and machinery wholly or mainly made of copper or brass), including tractors for agricultural purposes. Tinplates, terneplate, and galvanized sheets and manufactures from such plates and sheets are also placed on the free list.

### Credits as Basis for Future Foreign Trade

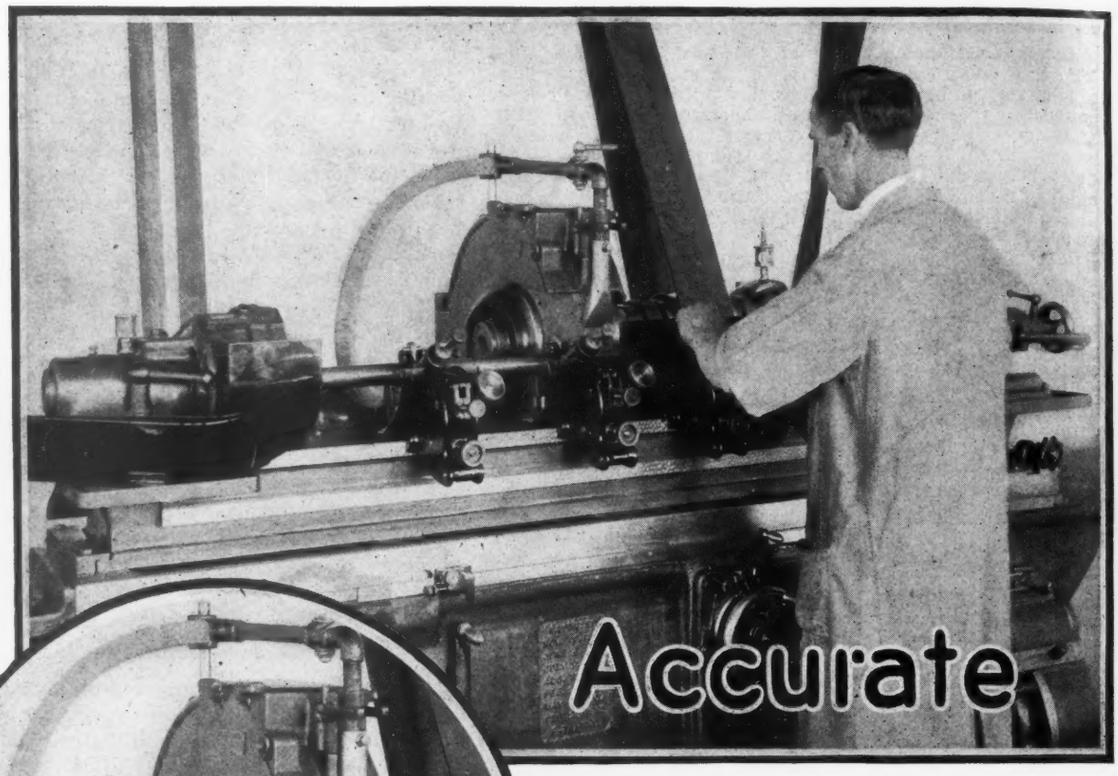
The vital necessity for granting more liberal credits to foreign purchasers of American products has been emphasized by many men familiar with the financial conditions in Europe. American banks must revise their point of view with regard to foreign credits and must no longer restrict such credits to sixty, ninety or one-hundred and twenty days. They must prepare to render to manufacturers and exporters the service which the present readjustment period makes imperative. England and Germany built up their great foreign trade prior to 1914 largely by making six months' time the selling basis for their goods, and in many instances longer periods were allowed. Charles H. Sabin, president of the Guaranty Trust Co. of New York, points out that if we are to hold our own in foreign trade, we must profit by the experience of other countries and adapt ourselves to the needs of the present situation. The present condition of foreign exchange, especially in the case of France and Italy, is making trade with these nations difficult, and it is highly important that other facilities be developed to promote trade. The discouragement of the buying of American goods in those countries where the exchange is unfavorable to the buyer will eventually result in a serious curtailment of American foreign business, unless counteracted by the extension of credits for a sufficient period to enable purchasers to pay at a more convenient time than the present.

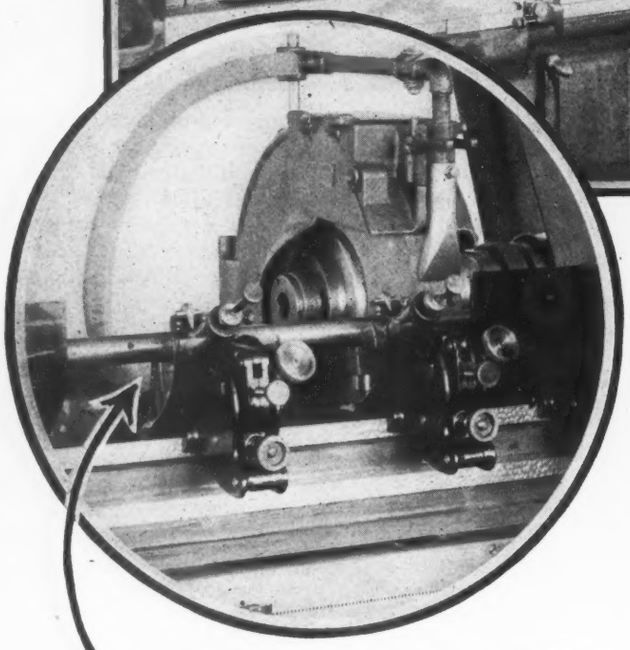
### Japan's Industrial Development

The extent of Japan's industrial expansion during the war may be best understood by quoting the following figures relating to the number of factories established and the number of employes: During the war about 14,000 factories were established, employing 270,000 workers, and capitalized at $220,000,000. Five thousand other factories were enlarged and their capitalization increased. Some 280,000 workmen were recruited from other occupations not industrial, and 160,000 were transferred from the older industries to the new ones established during the war.

* * *

The John Fritz medal, awarded under the auspices of the American Society of Mechanical Engineers, was presented Thursday, May 22, at the Engineering Societies' Building, 29 W. 39th St., New York City, to General G. W. Goethals in consideration of his eminent services as an engineer.



# On Extra Heavy Work

or long slender pieces, *accuracy* in grinding is dependent upon the use of suitable work rests. The work must be supported both at the front and under-sides. When thus properly supported the operator is able to take heavier cuts at faster speeds and feeds and the "sizing power" of the wheel is increased. That's why we equip our larger size plain grinding machines with Combination Plain and Universal Back Rests.

The illustration above shows the Combination Plain and Universal Back Rests as used on our Nos. 14 and 16 Plain Grinding Machines. The work is shown being supported by both shoes. Adjustments on these rests are simply and easily made. A clamping screw is provided to prevent the vibration of the machine disturbing the adjusting screw. These rests may also be used as plain back rests or as regular universal back rests.

## BROWN & SHARPE

**PLAIN GRINDING MACHINES**

***Send for Catalog No. 136.***

REPRESENTATIVES IN U. S. A.

BALTIMORE, MD., Carey Machinery & Supply Co.
CINCINNATI, O., INDIANAPOLIS, IND., The E. A. Kinsey Co.
SAN FRANCISCO, CAL., Pacific Tool & Supply Co.
CLEVELAND, O., DETROIT, MICH., Strong, Carlisle & Hammond Co.
ST. LOUIS, MO., Colcord-Wright Machinery & Supply Co.
SEATTLE, WASH., Perine Machinery Co.
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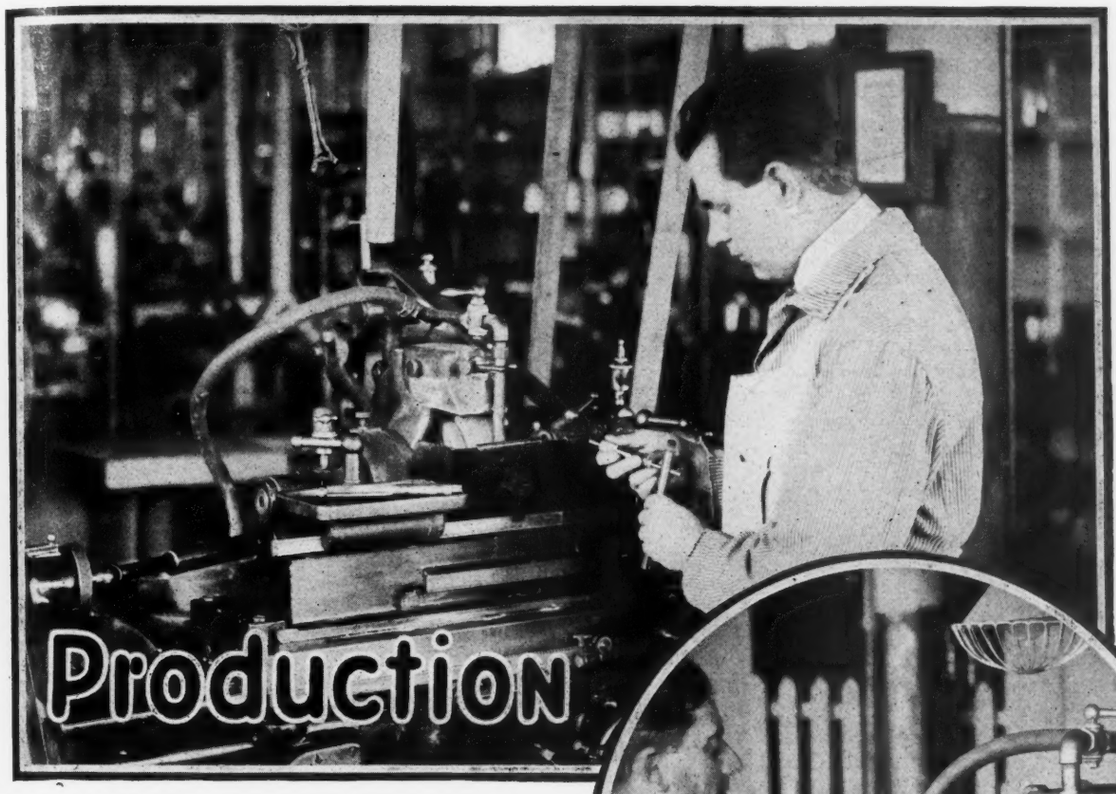
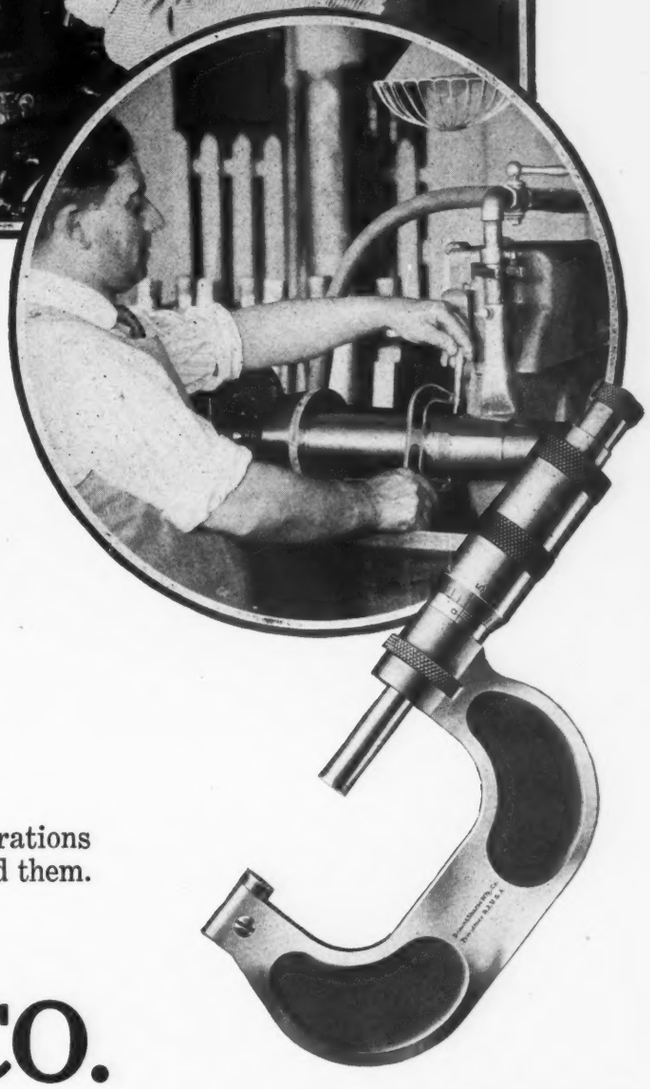
OFFICES: CHICAGO, ILL., 626-630 Washington Blvd.
PHILADELPHIA, PA., 1103-1105 Liberty Bldg.
PITTSBURGH, PA., 2538 Henry W. Oliver Building.

PROVIDENCE,

**BROWN & SHARPE OF NEW YORK, Inc.**
**Offices: New York City, 20 Vesey St.**



# Know, Don't Guess

It is much more satisfactory to *know* how near "to size" a piece is at any stage of the grinding than it is to *guess*. The operator who uses an accurate micrometer knows, not only just how near "to size" his work is at any time, but he also knows exactly how much more must be taken off before the work is ground to the required limits.

## BROWN & SHARPE

**PRECISION MACHINISTS' TOOLS**

are accepted as standard and three generations of machinists have used and recommended them.

***Send for Catalog 27***

# RPE MFG. CO.

## R. I., U. S. A.

**Rochester, 415 Chamber of Commerce Bldg.**
**Syracuse, Room 419 University Block**

**REPRESENTATIVES IN CANADA:**
Canadian Fairbanks-Morse Co., Ltd., TORONTO, MONTREAL, WINNIPEG, CALGARY, VANCOUVER, ST. JOHN, SASKATOON.

**REPRESENTATIVE IN AUSTRALASIA:**
R. L. Scrutton & Co., Ltd., Sydney, N. S. W.

## NEW CONGRESS MAY REPEAL SECOND-CLASS POSTAL ZONE LAW

Representative F. W. Mondell, Republican floor leader in the next House of Representatives, in discussing some of the policies that will be put into effect by the next Congress, has stated that one of the first legislative steps should be the repeal of the zone system applying to magazines and periodicals. "I regard the zone system as provincial, insular, and obnoxious, and as being against the interests of the entire country," said Mr. Mondell. "It works against the dissemination of literature and newspapers to all people equally, and to that extent prevents the entire people from being swayed or having the benefit of publications which are issued in sections of the country remote from them. What we want in this country is the people thinking alike and able to obtain all the information possible of a beneficial character upon the same basis. That is the purpose of the second-class rate. Homogeneity and unity would come through a flat rate for second-class matter. I have always opposed the zone system. It tends to separate the people into zones and communities with divergent views."

* * *

## RISE IN IRON AND STEEL PRICES DURING THE WAR

If the average price for iron and steel during the period from July 1, 1913, to June 30, 1914, is assumed as 100, the average price of finished steel products at the time of the armistice was 228, or an increase of 128 per cent. The present prices for finished steel products are 95 per cent higher than the prices during the year ending June 30, 1914. The wholesale prices of all commodities are now 97 per cent higher than they were in 1914, showing that steel prices are practically on a par with other prices at the present time. These prices are likely to remain reasonably stable for a long time to come. The greatest increase in wholesale prices of all commodities was 107 per cent.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC. REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of MACHINERY, published monthly at New York, N. Y., for April 1, 1919.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Alexander Luchars, who, having been duly sworn according to law, deposes and says that he is the President of The Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

| | |
|---|---|
| Publisher, The Industrial Press | 140-148 Lafayette St., New York |
| Editor, Erik Oberg | " " " " |
| Managing Editor, None | |
| Business Managers: Alexander Luchars, President | " " " " " |
| Business Managers: Matthew J. O'Neill, Treasurer and General Manager | " " " " " |

2. That the owners of 1 per cent or more of the total amount of stock are:

| | |
|---|---|
| The Industrial Press | 140-148 Lafayette St., New York |
| Alexander Luchars | " " " " " |
| Matthew J. O'Neill | " " " " " |
| Louis Pelletier | " " " " " |
| Erik Oberg | " " " " " |
| L. A. Bell | " " " " " |
| H. L. Ketchum | " " " " " |
| E. Y. Urban | " " " " " |

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

ALEXANDER LUCHARS, President.

Sworn to and subscribed before me this 26th day of March, 1919.

WILLIAM E. BACON,
(SEAL) Notary Public, New York County, No. 12.
New York Register, No. 10196.
(My commission expires March 30, 1920.)

## WESTINGHOUSE SCHOLARSHIPS

As a proper war memorial to the more than 8000 employes of the Westinghouse Electric & Mfg. Co. who have entered the service of the Government in the war, the company has decided to establish four technical scholarships each year under the following general conditions: Candidates will be limited to sons of employes of the Westinghouse Electric & Mfg. Co. and its subsidiaries, who shall have been employes in good standing for a period of five years. Two of such annual scholarships may be open to the younger employes of the company or its subsidiaries who have been in their service for a period of at least two years and who do not exceed the age of twenty-three. The selection is to be determined by competitive examination to be conducted annually by the company's educational department, which will take into account not only the applicant's academic training and preparedness, but also personal qualifications, general character, and aptitude. Scholarships will entitle the successful candidate to pursue a four year's course in any technical school or college that he may select with the approval of the committee. The scholar may pursue a course in any branch of engineering that he may select. Scholarships will be granted for one year only, but will be continued for the full four years provided the scholar maintains the academic and other standards required by the college or institution in which he elects to pursue his course of study. Each scholarship carries with it an annual payment of $500 to be made in two installments.

## PERSONALS

C. W. JACOBY has been made manager of the Philadelphia office and warehouse of Peter A. Frasse & Co., Inc., 625 Arch St., Philadelphia, Pa., succeeding W. F. Moore.

E. J. KEARNEY of the Kearney & Trecker Co., Milwaukee, Wis., has been devoting his entire time for several months to the various Liberty Loan and War Savings campaigns.

O. T. SMITH, for several years connected with the Colonial Steel Co. in the New England district, is now associated with the Aborn Steel Co., Inc., at 171 High St., Boston, Mass.

RAYMOND F. BROWN has been appointed purchasing agent of the Bantam Ball Bearing Co., Bantam, Conn., succeeding C. D. Stoddard, who has entered the automobile and garage business.

A. C. LINDHOLM, formerly mechanical engineer with the Colt's Patent Fire Arms Mfg. Co., Hartford, Conn., is now connected with the Franklin Machine & Tool Co., of Springfield, Mass., as general manager.

ANDREW V. TEREK, who has recently been discharged from the Naval Aviation Service, has returned to the employ of the Bantam Ball Bearing Co., Bantam, Conn., as master mechanic in charge of the upkeep of the factory.

M. H. NEEDHAM, for two years past vice-president and general manager of the Barrett-Cravens Co., Chicago, Ill., builder of the Barrett lift-trucks, has resigned his position with this company; his plans for the future will be announced later.

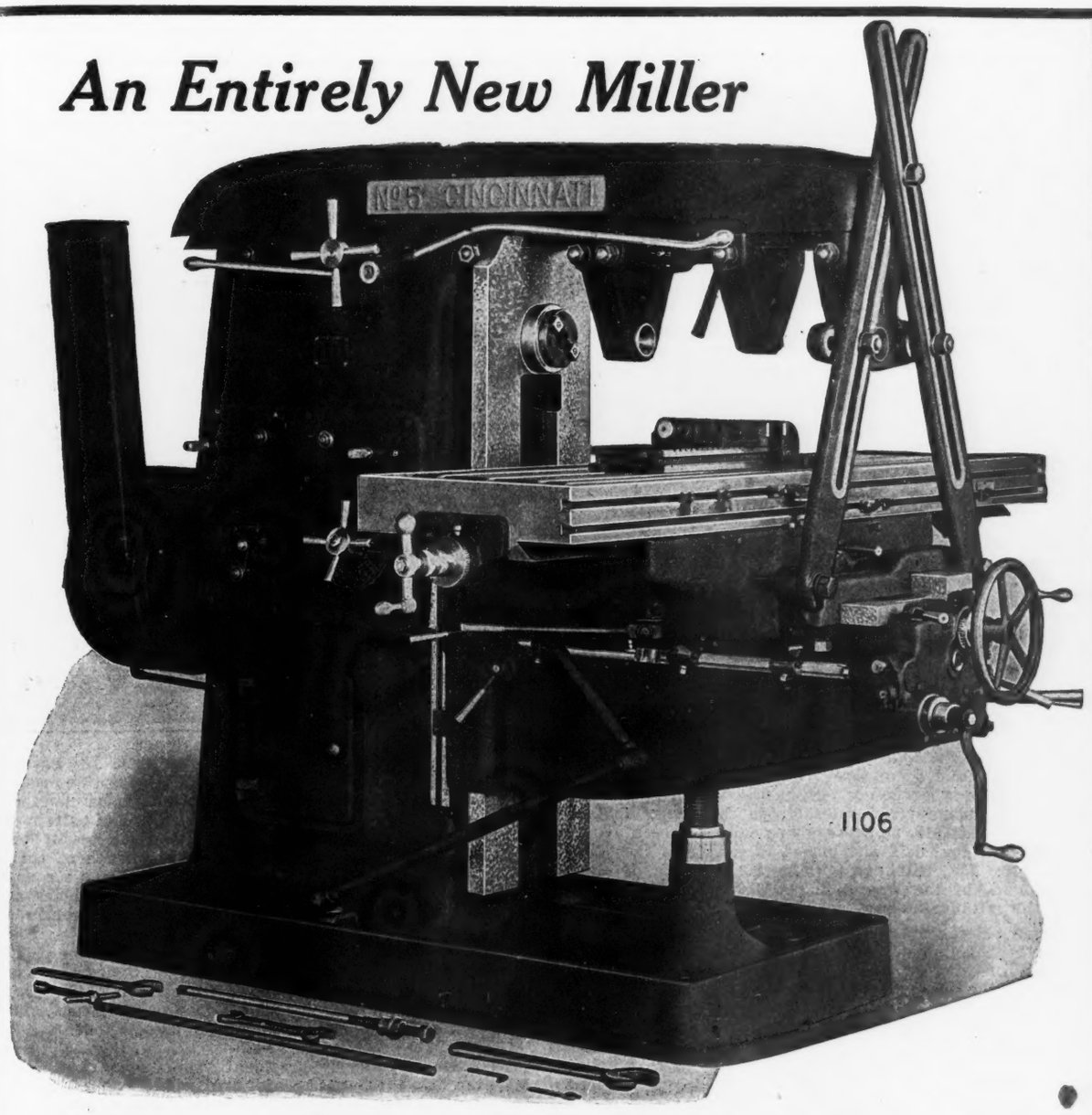
THEODORE BUTLER, manager of the London office of the Whitman & Barnes Mfg. Co., Akron, Ohio, sailed May 14 for London, after making a tour of the Akron twist drill and reamer factory and the Chicago wrench and drop-forge plant of the company.

CALVERT TOWNLEY, assistant to the president of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., was elected president of the American Institute of Electrical Engineers at the annual business meeting of the institute held on May 16, in New York City.

E. W. TEMPLIN, formerly assistant engineer of the Selden Motor Truck Co., and more recently production manager of the Bessemer Motor Truck Co., has become associated with the Goodyear Tire & Rubber Co., Akron, Ohio, in the capacity of motor truck engineer, attached to the development department.

CHARLES T. FALLON has been appointed Boston district sales manager of the Tacony Steel Co., Tacony, Philadelphia, Pa., in charge of the new offices in the Oliver Building, Boston. Mr. Fallon was previously connected with Wheelock, Lovejoy & Co., and has been in the United States Naval Reserve Flying Corps since 1917.

# *An Entirely New Miller*




# The Cincinnati No. 5

Patent Rights Fully Reserved

## *Sixteen Big Productive Features*

Intermittent Feed with power quick traverse.
Rectangular Overarm.
Square Gibbed Bearings with narrow guides.
Feed Changes made in front of machine.
Individual Feed Control Levers at front of machine.
Individual Feed Control Levers at side of machine for control from behind the table.
Automatic Lubrication, for mechanism in column.
Centralized Oiling for other mechanisms, six stations.
Stream Lubrication for cutters and work.
Sliding Gears for speed and feed changes.
Safety Couplings for both feed and quick traverse.
Main Starting Lever, controlled from front or rear.
Automatic Brake for spindle stop.
Cincinnati Flanged Spindle End.
No. 14 Taper Hole in spindle for large arbors.
Spindle Reverse in machine.

## THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI OHIO, U. S. A.

F. X. MEEHAN has become associated with the Walter A. Zelnicker Supply Co., St. Louis, Mo., in the capacity of advertising manager. Mr. Meehan has been connected in various executive capacities with Fairbanks-Morse & Co. for six years, the Atchison Topeka & Santa Fe Railroad Co. Coast Lines for two years, and the St. Louis Smelting & Refining Works of the National Lead Co. for two years.

W. W. FARLETON, who has been purchasing agent and traffic manager with the Southern Manganese Corporation for the past two years, has become identified with the Anniston Steel Co., Anniston, Ala., in the sales department, salvage division. Mr. Farleton will be in charge of the sales of all the equipment recently acquired by this company from the Illinois Car & Equipment Co., consisting of wood- and iron-working machinery of all kinds, Corliss and other engines, boilers, scrap, junk, etc.

H. A. HASSALQUIST, who for the past twenty-nine years has been in the employ of the Elgin National Watch Co., the South Bend Watch Co., the Victor Talking Machine Co., the MacIntyre Watch Co. and the Wahl Adding Machine Co., is now superintendent and production engineer of the Collins Rotary Safety Razor Sales Co., Chicago, Ill. Mr. Hassalquist has been in the employ of the companies mentioned in the capacity of expert mechanic, superintendent, mechanical engineer, and production engineer.

CHARLES H. STODDARD has been appointed consulting marine engineer with the Heine Safety Boiler Co., St. Louis, Mo. Mr. Stoddard has been chief engineer of the Fulton Iron Works and of the Risdon Iron Works of San Francisco, and for nearly three years was civilian superintendent of shops at the Mare Island Navy Yard. He was also chief engineer of the Moore & Scott Iron Works, which is now known as the Moore Shipbuilding Co., and assisted in the expansion of that company from a repair shop employing 250 men to a shipyard employing 9500 men and doing government work.

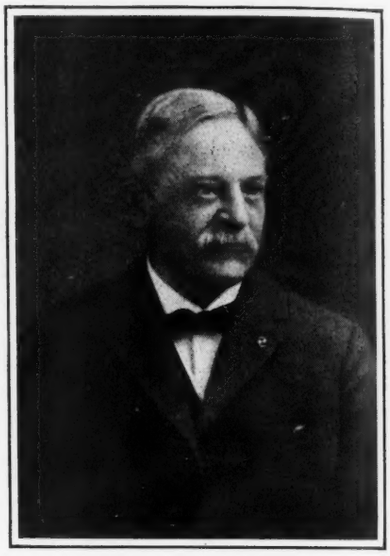
A. E. HITCHNER has been appointed manager of the mining section of the industrial sales department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Mr. Hitchner served a two-year apprenticeship with the Baldwin Locomotive Works, and spent three years with the Link-Belt Co. on construction work before joining the Westinghouse sales organization as industrial salesman in the Philadelphia office in 1909. In 1912, he was sent as sales representative to the anthracite coal field and placed in charge of the Wilkes Barre office. Mr. Hitchner will handle the sale of all apparatus made by the Westinghouse Electric & Mfg. Co. for use in the mining industry.

BENJAMIN G. LAMME, chief engineer of the Westinghouse Electric & Mfg. Co., was awarded the Edison medal by the American Institute of Electrical Engineers, at the annual meeting of the institute in New York City, May 16. The medal is awarded for "invention and development of electrical machinery." Mr. Lamme was born in 1864, on a farm near Springfield, Ohio, and graduated from the mechanical engineering course at Ohio State University in 1888. Since 1889 he has been in the employ of the Westinghouse Electric & Mfg. Co., having been made assistant chief engineer in 1900 and chief engineer in 1903, which latter position he has held ever since. This has distinguished him not only as an engineer but also as an inventor, 150 patents having been granted to him relating almost exclusively to dynamo-electric machinery.

## OBITUARIES

### EDWARD PAUL REICHHELM

EDWARD PAUL REICHHELM, founder and president of E. P. Reichhelm & Co., Inc., New York City, the American Gas Furnace Co., Elizabeth, N. J., and the American Swiss File & Tool Co., Elizabethport, N. J., died at his home in Bayonne, N. J., on May 4 in his seventy-sixth year. Mr. Reichhelm came to this country with his parents at the age of five, and upon finishing the regular courses in school and academy, he studied mechanical engineering in the evening school of the Cooper Institute while he was occupied during the day as mechanic's apprentice with A. & F. Brown, machinists. At the outbreak of the Civil War, he enlisted in the Third Missouri Infantry Regiment in which he became Sergeant-Major, and was ultimately advanced to the rank of Major. He established himself in the business of tools and supplies at 65 Nassau St., in 1876, and organized the American Gas Furnace Co. in 1887. In 1900, he organized the American Swiss File & Tool Co. in Elizabethport, N. J. The three organizations established by him and built up from modest beginnings to their present standing testify to his unusual executive ability and energy. The three corporations are conducted under the management of his sons and other partners in accord with the business policies formulated by him and which his successors will continue to follow.



Since retirement from active business during the past five years, Mr. Reichhelm's energies have been devoted mainly to the welfare of the community in which he lived. He had many friends, who will mourn his loss as an earnest, sincere friend in all his business and private associations.

FRED HOLZ, formerly president of the Cincinnati Milling Machine Co., Cincinnati, Ohio, died suddenly on May 12, at the age of sixty-seven years. Mr. Holz retired about fifteen years ago from the Cincinnati Milling Machine Co., with which he had been connected since it was first organized, and had not been active in the machine tool business since that time. He is survived by a son, Herman Holz, who is president of the National Machine Tool Co., Cincinnati, Ohio.

## COMING EVENTS

**June 16-20**—Semi-annual convention of the American Society of Mechanical Engineers, at Detroit, Mich. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

**June 19-21**—Joint convention of the American Drop Forge Association and the Drop Forge Supply Association, at Pittsburg, Pa., in the Chamber of Commerce Building. Secretary, Arthur W. Peterson, 108 Smithfield St., Pittsburg, Pa.

**June 20-21**—Eighth annual convention of the American Society of Marine Draftsmen at Boston, Mass.; headquarters, Hotel Brunswick. Secretary, B. G. Barnes, 1596 North Ave., Bridgeport, Conn.

**June 23-27**—Summer meeting of the Society of Automotive Engineers at Ottawa Beach, Mich. Reservations can be made through the offices of the society at 29 W. 39th St., New York City.

**June 24-27**—Twenty-second annual meeting of the American Society for Testing Materials at Atlantic City, N. J.; headquarters, Hotel Traymore.

**June 26**—Annual meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 857 Genesee St., Rochester, N. Y.

**September 22-27**—First annual convention and exhibit of the American Steel Treaters' Society in Chicago, Ill. Business manager, W. H. Eisenman, 154 E. Erie St., Chicago, Ill.

**September 29-October 4**—Eighth annual congress of the National Safety Council at Cleveland, Ohio.

## SOCIETIES, SCHOOLS AND COLLEGES

**Clarkson College of Technology**, Potsdam, N. Y. Bulletin for 1919, containing calendar for 1918-1919 and for 1919-1920, as well as outline of courses, etc.

**Columbia University**, Morningside Heights, New York City. Announcement of the day and evening classes of the summer session which commences July 7, and ends August 15.

**Workingmen's College, Inc., Melbourne Technical School**, Melbourne, Australia. Prospectus for 1919, containing outline of courses and other information relating to the institute.

**Society for Electrical Development, Inc.**, 29 W. 39th St., New York City, is issuing a booklet entitled "What Licked the Kaiser?", showing that the fundamental feature in winning the war was cooperation, and pointing to the need for cooperation in the electrical industries. Some of the work of the society and the results accomplished by it are described in the pamphlet.

## BOOKS AND PAMPHLETS

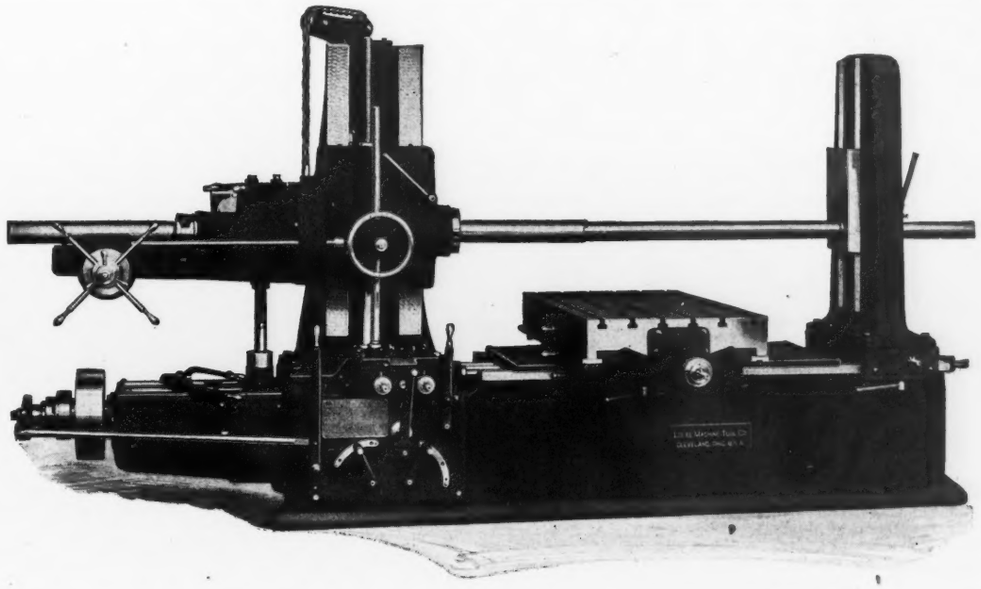
**Aluminum and its Light Alloys.** 120 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 76 of the Bureau of Standards. Price, 20 cents.

**Construction Materials and Machinery in Chile, Peru, and Ecuador.** By W. W. Ewing, trade commissioner. 204 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Special Agent's Series No. 175. Sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 20 cents.

**Fundamental Electricity.** By W. P. Wieman. 128 pages, 4 by 6 inches; 27 illustrations. Published by the Wieman Co., 614 E. North Ave., Pittsburg, Pa. Price, $2, postpaid.

This book discusses the elementary principles of electricity and is intended to give data that will form a foundation for an understanding of the subject. The author has given considerable space to the subject of astronomy in order to show the relationship that exists between astronomy and electricity.

**The Principles Underlying Radio Communication.** 355 pages, 4 by 7 inches. Prepared by the Bureau of Standards under the direction of the Office of the Chief Signal Officer of the



We were once asked to criticise a new machine and gave our opinion that the spindle would soon be out of line because the bearing was short, to which the maker replied: "If we made that bearing as long as it ought to be we wouldn't make a cent on the machine."

WE BELIEVE THIS POLICY IS WRONG.

One customer who has a

# "PRECISION"

## Boring, Drilling and Milling Machine

### 13 YEARS OLD

recently said: "The machine is so accurate that it seems as though it must have been *made to order.*"

We admit that this machine has been used mostly on Jig Work; yet our customer's remarks show that the machine was properly designed to resist wear and was made to give service and satisfaction, and not merely to sell.

***Consult your own interests and let your final decision be a "Precision."***

**LUCAS MACHINE** NOW AND ALWAYS OF **TOOL COMPANY**

**CLEVELAND, OHIO, U. S. A.**

**Army, Training Section, as Radio Pamphlet No. 40.** Sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 55 cents.

This book presents briefly the basic facts and principles of electromagnetism and their application to radio communication. An effort has been made to present these topics in a simple manner for the use of students having very little mathematical preparation. Frequent references to standard books are given for the benefit of those who wish to study this subject to a greater extent.

**Labor Turnover, Loyalty, and Duty.** By Fred H. Colvin. 152 pages, 5 by 7½ inches; illustrated. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $1.50, net.

This book discusses some of the many complicated labor problems which confront the employer at the present time, including those relating to democracy in industry, training of workers, reducing labor turnover, shop government, and the relations between the employer and the employe. It is believed that the good of the country as well as of the industries demands a careful consideration of these problems, and the author has endeavored to suggest some possible solutions. The book describes certain methods of dealing with labor and of arousing the interest of the employe in his work that have proved successful in actual practice. The following chapter heads will give an idea of the scope of the work: Lack of Interest and Labor Turnover; Building an Organization; Forgetting the Human Element; Securing Interest by Instruction; Instruction in the Shop; Non-financial Incentives; The Employment Manager; Latest Ideas of Leading Men; and Collective Bargaining.

**Motor Vehicle Engineering.** By Ethelbert Favary. 325 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $3.00, net.

The object of this book is to give in a concise and simple manner the information needed by the designer and the automobile engineer in their everyday work, using only the simplest of mathematics. The book is also intended for draftsmen, technical graduates, mechanics, and others engaged in the different branches of engineering who wish to obtain technical training in motor vehicle engineering, including design and testing. The author has endeavored to bring the information up to date, and has given data of the latest designs, especially gathered for this purpose from the leading manufacturers. Considerable space has been given to truck engine design on account of the increasing importance of this subject. The book gives formulas for determining the strength and dimensions of the various parts of motor vehicle engines, and examples of standard designs of all parts of engines are included. The chapter heads are as follows: Engine Principles; Compression, Combustion, and Expansion of Gas; Cylinder Clearance and Compression; Theory of Four-cycle Engine Disclosed by Indicator Diagram; Cylinder Dimensions; Valves; Valve Timing, Cams, Camshafts; Camshaft and Accessory Drives; Pistons; Connecting-rods; Crankshafts—Engine Balancing; Kinetic Forces; Flywheels; Crankcases; Lubrication of Engines; Offset Cylinders; Manifolds; Engine Cooling, Combustion Chamber, etc.; Power of Engines, Efficiency, Torque; Brake Horsepower Tests of Automobile Engines; Mean Effective Pressure; The Manograph; Brake Horsepower Test by Electric Dynamometer; Brake Horsepower Test by Hydraulic Dynamometer; Tractive Effort and Power Required for Motor Vehicles; Tractive Factor, Torque, etc.; Materials; Hardening Steel; Methods of Testing the Hardness of Metals.

## NEW CATALOGUES AND CIRCULARS

**Metalwood Mfg. Co.**, Detroit, Mich. Circular B 56, descriptive of the Metalwood 35-ton horizontal forcing press.

**Milwaukee Auto Engine & Supply Co.**, Milwaukee, Wis. Catalogue 12 of timers and bumpers for use on automobiles.

**Thomas Spacing Machine Co.**, Fulton Bldg., Pittsburg, Pa. Circular illustrating an angle beveling machine for ship work.

**Fulflo Pump Co.**, Blanchester, Ohio. Leaflet of "Fulflo" motor-driven pumps, having a capacity of from 5 to 60 gallons per minute.

**Universal Drafting Machine Co.**, Cleveland, Ohio. Catalogue descriptive of the Universal drafting machine and the accessories furnished with it.

**H. Zering Mfg. Co.**, Cincinnati, Ohio. Catalogue 17 of hand- and power-driven trucks, casters, hand carts, wheels, tractors, automobile turntables, etc.

**Shepard Electric Crane & Hoist Co.**, Montour Falls, N. Y. Circular advertising Shepard electric cranes and hoists, and showing installations for various classes of work.

**Griscom-Russell Co.**, 90 West St., New York City. Bulletin 230, descriptive of the Reilly water heater of the single-pass and two-pass types, for use in power plants.

**Sprague Electric Works of General Electric Co.**, 527-531 W. 34th St., New York City. Pamphlet of Sprague direct- and alternating-current electric fans and ventilating outfits.

**Taft-Peirce Mfg. Co.**, Woonsocket, R. I. Price list of Taft-Peirce plug and ring thread gages, snap gages, sine bars, V-blocks, parallels, angle-irons, reamers, milling cutters, arbors, etc.

**Reed & Prince Mfg. Co.**, Worcester, Mass. Catalogue giving dimensions and prices of the regular products of the company, which include screws, bolts, rods, rivets, burrs, nuts, etc.

**Peter A. Frasse & Co., Inc.**, 417-421 Canal St., New York City. Price list of flexible-back hand and power hacksaws. Stock list of Shelby cold-drawn seamless steel tubing in round and square sizes.

**Langstadt-Meyer Co.**, Appleton, Wis. Bulletin 12, describing Langstadt-Meyer direct-connected generating units. Bulletin 54, giving specifications for Langstadt-Meyer private electric light plants.

**High Speed Hammer Co., Inc.**, Rochester, N. Y. Catalogue entitled "Let Us Shoulder Your Riveting Problems," illustrating and giving specifications for the company's line of high-speed riveting hammers.

**V. E. Lapointe Mfg. Co.**, Hartford, Conn. Circular of the "Velco" lathe broaching attachment, which has a stroke of 48 inches and a capacity for broaching square holes of 1½ inch and ½-inch keyways.

**Machinery Co. of America**, Big Rapids, Mich. Catalogue 31, treating of the saw- and knife-fitting machinery and tools made by this company, including emery wheel dressers, saw sharpeners, cup-wheel grinders, etc.

**Walter A. Zelnicker Supply Co.**, St. Louis, Mo. Bulletin 258, listing the new and second-hand rails and accessories carried in stock. Bulletin 263, listing new and second-hand portable hand-power pipe-threading machines.

**Albro-Clem Elevator Co.**, 501 Erie Ave., East Philadelphia, Pa. Circular descriptive of Hindley worm-gearing which is claimed to have superior load-carrying ability and to be especially adapted for use on constantly running machines.

**Gulowsen Grei Engine Co.**, Salmon Bay, Seattle, Wash. Catalogue 2 of marine and stationary heavy oil engines, describing the principle of operation, method of starting, construction details, and special features of the various types.

**Union Switch & Signal Co.**, Swissvale, Pa., is issuing Bulletin 95 descriptive of the city of Pittsburg, illustrated with views of the city. The booklet also illustrates examples of work produced by the drop-forge department of the company.

**Diamond Chain & Mfg. Co.**, Indianapolis, Ind. Booklet entitled "Introducing the Makers of Diamond Chains," containing some facts concerning the organization, plant, facilities and policies of the company, illustrated with photographs of the officers and views of the plant.

**Hammond Steel Co., Inc.**, Syracuse, N. Y. Booklet giving information concerning the various grades of tool and alloy steels made by this company. The type of work for which the steel is especially adapted and the hardening treatment employed are stated for each grade.

**Page Steel & Wire Co.**, Monessen, Pa. Catalogue of "Aristos Copperweld" copper-clad steel wire, giving information pertaining to the properties of this wire. The manufacture of the wire is described, and the results of tests are given, showing its electrical and mechanical properties.

**K-G Welding & Cutting Co., Inc.**, 556 W. 34th St., New York City. Catalogue of oxy-acetylene welding and cutting equipment, illustrating and giving specifications for the various styles of torches made for different classes of work, pressure regulators, and acetylene welding generators.

**Kinite Co. of Milwaukee**, 1338 St. Paul Ave., Milwaukee, Wis. Folder descriptive of "Kinite," a patented alloy steel which is cast in special molds that give it the appearance of a smooth forging, and is especially adapted for making cutters, dies, taps and other tools with multiple cutting edges.

**Cutler-Hammer Mfg. Co.**, Milwaukee, Wis. Folder entitled "Melting Metal with Electrically Heated Pots," describing the floor type melting pots, made in 10- and 25-pound sizes, and the bench type, made in 50-, 100-, and 150-pound sizes. Folder of Cutler-Hammer push-button porcelain sockets for electric lights.

**Electric Furnace Co.**, Alliance, Ohio. Booklet 5 B, illustrating and describing Baily electric furnaces for melting non-ferrous metals. The booklet shows a few typical installations and gives information relating to fuel cost, reliability of essential furnace parts, foundry conditions, quality of metal produced, and comparative metal losses.

**Gisholt Machine Co.**, Madison, Wis. Bulletin comprising a condensed catalogue of all the Gisholt products, which include hand-operated and automatic turret lathes, vertical boring and turning mills, universal tool grinders, horizontal boring and drilling machines, toolpost tool-holders, adjustable reamers, boring-bars, and periodographs.

**Reynolds Machine Co.**, Massillon, Ohio. Catalogue F of Reynolds power-driven, automatic, magazine-feed screw-driving machines, for wood or machine screws. These machines are designed to handle three sizes of screws of all styles, and the range of screws handled can be increased by the provision of special interchangeable parts.

**Frank D. Chase, Inc.**, Whitehall Bldg., New York City, and 645 N. Michigan Ave., Chicago, Ill. Booklet entitled, "Ideals and Convictions," containing reprints of advertisements originally published in the "Chicago Tribune," setting forth briefly what the company is doing as industrial engineers. The booklet is illustrated with views of plants constructed by the company.

**Universal Bearing Co.**, Lorain, Ohio. Circular giving information on characteristics of the "Universal" bearing metal made by this company, which is intended for use under severe conditions of service. Circular containing letters of recommendation from users of "Universal" bearing metal. The selling agents for the company are E. R. Senn & Co., Inc., 52 Vanderbilt Ave., New York City.

**Electric Welding Co.**, 2114 Superior Viaduct, Cleveland, Ohio. Booklet descriptive of the Elweld process of welding high-speed steel lathe, planer, and other tools, which have become too short to use in the regular way, to tool steel shanks. The catalogue gives concrete examples of the saving that can be effected by this practice and shows a number of the tools that can be welded in this way.

**Simonds Mfg. Co.**, Fitchburg, Mass. Catalogue entitled "Simonds Saw Steel Products in the War," describing the war work accomplished by this concern, illustrated with views showing the manufacture of armor plate in the plant, and sketches showing the use to which the armor plate is put in the Army and Navy. Several pages of illustrations are included showing Simonds hacksaws, band saws, cut-off saws, etc.

**Carpenter Steel Co.**, Reading, Pa. Catalogue 8, containing data on Carpenter alloy steels, which are intended for use wherever great strength and stability under severe service are demanded, together with economy in weight and space. In addition to the description of the special steels given, diagrams are presented showing their physical properties in relation to drawing temperatures and the location of critical points.

**Doehler Die-Casting Co.**, Court, Ninth and Huntington Sts., Brooklyn, N. Y. Booklet entitled "Do-Di Finished Brass Castings," treating of this company's brass die-casting process by means of which solid, homogeneous castings are produced, having such smooth surfaces that no machining is necessary unless a specially high finish is required. Examples of work that may be advantageously produced by the use of this process are shown.

**Morse Chain Co.**, Ithaca, N. Y. Pamphlet entitled "Chain Drives," containing an article by J. S. White which was reprinted from the 1919 Year Book of the National Association of Cotton Manufacturers. The purpose of the booklet is to present to textile engineers a synopsis of the general subject of chain driving and to indicate the possibilities of chain driving in this field, and the advantages accruing from the use of chain drives in general power transmission work.

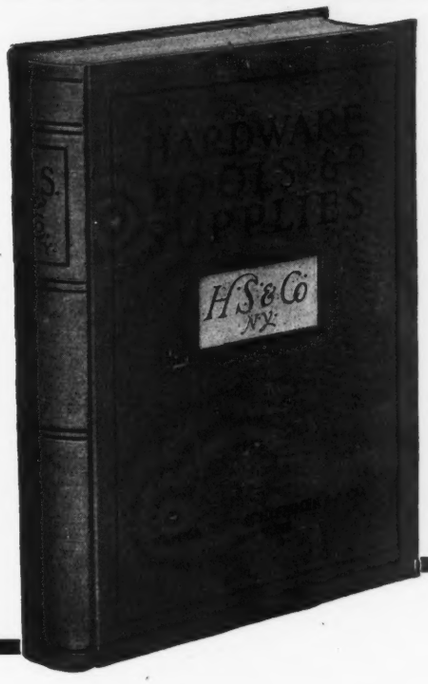
**Fellows Gear Shaper Co.**, Springfield, Vt. Sixth edition of the book entitled "Commercial Gear Cutting," which comprises a treatise on commercial gear cutting, dealing particularly with the production of spur, helical, and internal gears on the gear shaper. The concluding chapter of the book points out the application of the gear shaper to other work than the production of gears, including the making of cams and other parts of irregular shape, graduating, dividing, etc.

**Solar Metal Products Co., Inc.**, Columbus, Ohio. Pamphlet entitled "Getting Results in Sheet Steel Work," showing views in the company's factory and examples of its sheet steel products. The company specializes in the production of sheet steel between 10 and 20 gage, and handles all operations upon it, including shearing, punching, blanking, breaking, forming, drawing, rolling, welding, annealing, retinning, grinding, fitting, riveting, painting, finishing, and assembling.

**Guaranty Trust Co. of New York**, 140 Broadway, New York City, is issuing a pamphlet entitled "How Business with Foreign Countries is Financed." The information given is intended to be of assistance to those who wish to enter the field of foreign trade or to extend their foreign business. The company is also issuing a pamphlet entitled "Banking Service for Foreign Trade," giving information concerning the activities, functions and facilities of the foreign department of the company.

**Ingersoll Milling Machine Co.**, Rockford, Ill. Catalogue 38 of Ingersoll inserted-tooth milling cutters. The book shows a series of standardized face mills, adapted for milling cast iron, steel forgings and castings, and aluminum, as well as end-mills, side-mills, arbor-mills, interlocking cutters, and inserted-tooth profile milling cutters. There are also listed standard types of solid milling cutters. The different types of milling cutters are shown in use on various classes of work, and dimensions and specifications are given.

**Yale & Towne Mfg. Co.**, 9 E. 40th St., New York City, has published a booklet comprising a semi-centennial souvenir of the company, which was established in 1868. The booklet contains a history of the origin of a number of the well-known Yale & Towne products, such as locks,




WHEN YOU WANT

# TOOLS HARDWARE AND SUPPLIES

First you need our large catalog showing a full line of Bolts, Screws, Nuts, Washers, Rivets, Burrs and a full assortment of Tools, including Drills, Files, Reamers, Taps, Dies, Wrenches, Hammers, Pliers, etc., etc. During the past few years' "rush" many very large concerns have found our stock a most handy source for large and varied assortments of staple supplies.

**For 71 years** we have been handling this line, and during this period our hobby has been Quality. In your dealings with us you will have the satisfaction of knowing that you are getting the best the market offers and at lowest current rates consistent with quality.

***In corresponding about Catalog please mention Catalog No. 198***

## HAMMACHER, SCHLEMMER & CO.

**NEW YORK SINCE 1848** **4th Avenue and 13th Street**

chain blocks, door-closers, etc., as well as information concerning the founders of the company. It describes the growth of the plant and of the line, the activities undertaken during the war, and gives information concerning the present organization, provisions for employes, etc.

## TRADE NOTES

**Cline Electric Mfg. Co.** has removed its offices to the Marbridge Building, Broadway, between 34th and 35th Sts., New York City.

**Slocum, Avram & Slocum Laboratories, Inc.,** has moved its executive offices from 30 Pine St. to the fortieth floor of the Woolworth Building.

**George A. Haws, Inc.,** is now located at 395 Broadway, New York City, to which address all correspondence should be sent. The factory is located at Carlstadt, N. J.

**Wilson-Maeulen Co., Inc.,** 783 E. 142nd St., New York City, manufacturer of pyrometers, has opened a branch office in Chicago, in the Monroe Building, with F. C. Baker in charge.

**National Device & Drill Co.,** Ypsilanti, Mich., manufacturer of high-speed forged twist drills, has changed its name to the Ypsilanti Twist Drill Co. The new general manager is H. A. Bisbee.

**L. V. Estes, Inc.,** industrial engineers and accountants, have removed their offices from the McCormick Building, Chicago, Ill., to the Century Building, 202 S. State St., where they occupy the entire fifteenth floor.

**American Broach & Machine Co.,** Ann Arbor, Mich., is beginning the construction of a plant on a site recently purchased in Ann Arbor, Mich., which will be devoted entirely to the manufacture of broaching equipment.

**Van Dorn Electric Tool Co.,** Cleveland, Ohio, manufacturer of portable electric drills, reamers, and grinders, has opened an office at 527 S. Dearborn St., Chicago, Ill., with William Cottrell, sales manager, in charge.

**Max Ams Machine Co.** has removed its executive and sales offices from the factory at Bridgeport, Conn., to the home office at 101 Park Ave., New York City. All correspondence should be addressed to the New York office.

**Carborundum Co.,** Niagara Falls, N. Y., recently elected Frank J. Tone president, succeeding Frank W. Haskell. George R. Rayner has been made vice-president, succeeding R. B. Mellon, of Pittsburg, and F. H. Manley retains the office of treasurer.

**Hatton, Klein & Holmes** is a firm recently organized at Cedar Rapids, Iowa, by Norman Hatton, William J. Klein, and S. E Holmes, to engage in general engineering, architecture, machinery lay-outs, heating and ventilating, and industrial engineering.

**Taft-Peirce Mfg. Co.,** Woonsocket, R. I., has appointed the following companies as exclusive agents in the territories in which they are located: Cadillac Tool Co., Detroit, Mich.; Syracuse Supply Co., Syracuse, N. Y.; and Sherritt & Stoer Co., Philadelphia, Pa.

**Rifaw Metal Sales Corporation,** Pittsburg Life Bldg., Pittsburg, Pa., manufacturer of iron and steel products, has recently obtained a contract for machinery to be installed in the new plant of the Colonial Concrete Products Co., which is being constructed at Glenshaw, Pa.

**Joseph Dixon Crucible Co.,** Jersey City, N. J., at its annual meeting on April 21, elected the following officers for the ensuing year: George T. Smith, president; George E. Long, vice-president; J. H. Schermerhorn, vice-president; Harry Dailey, secretary; William Koester, treasurer; and Albert Norris, assistant, secretary and treasurer.

**Joseph Dixon Crucible Co.,** Jersey City, N. J., has removed its Philadelphia sales office from 1020 Arch St., to Rooms 801-802, Finance Building, S. Penn Square, Philadelphia, Pa. The Philadelphia office is under the management of W. G. Stringer, who has been with the company since 1898.

**Tacony Steel Co.,** Tacony, Philadelphia, Pa., at a recent meeting elected J. B. Warren president and general manager of the company; George Satterthwaite, vice-president and treasurer; and Henry T. Stetson, secretary. The company has recently completed a 150-foot extension to its main press shop.

**Sundstrom Mfg. Co.,** 32nd and Shields Ave., Chicago, Ill., has changed its name to the Rex Machine Co. The company will manufacture and market the Rex line of automotive air equipment in addition to dies and tools under the same organization as heretofore. G. E. Sundstrom is president of the concern.

**V. E. Lapointe Mfg. Co.,** formerly located at Hartford, Conn., announces that the company is now moving into a larger shop in Manchester, Conn., and expects to be running full force in the new plant about June 15. The change in location was made necessary by the increased business of the company.

**Rickert-Shafer Co.,** 612 W. 12th St., Erie, Pa., maker of tapping machines and tools, announces that the company has recently made large shipments of small tools to Belgium and Sweden, and reports that both domestic and foreign business is very active, requiring the running of the factory on full time with a full force.

**Booth-Hall Co.,** designer and builder of electric furnaces, announces the removal of its executive and sales offices to Rooms 1007-1008, Hearst Building, 326 W. Madison St., Chicago, Ill. This change was necessitated by new arrangements that have been made in connection with the manufacture of the company's electric furnace equipment.

**B. J. Stamping Co.,** 1435-1437 Dorr St., Toledo, Ohio, has been organized for the production of metal stampings, drawing, and press work in general. The officers are Jerry Bingham, president and general manager; and Chester Hand, general superintendent. The directors will be Jerry Bingham, Chester Hand, and William Peters, all of Toledo.

**Van Dorn & Dutton Co.,** Cleveland, Ohio, manufacturer of gears, has opened branch offices in New York and Chicago. Harry F. Keegan, formerly with the Chicago Surface Lines, will manage the Chicago branch, which is located at 1241 First National Bank Bldg. John Keegan will manage the New York City office, Room 317, 30 Church St.

**Brownlie & Green, Ltd.,** Church St., Cheetham, Manchester, England, technical chemists and engineers, specialists in fuel economy, are distributing two pamphlets containing reprints of articles from "Engineering" entitled "Exact Data on the Running of Steam Boiler Plants," and "Coal Saving by the Scientific Control of Steam Boiler Plants."

**Paul W. Koch & Co.,** 19 S. Wells St., Chicago, Ill., have opened Pacific coast offices to take care of the sales of the "Jiffy" adjustable cutter, "Jiffy" speed punch, and other "Jiffy" labor-saving tools at the following addresses: 114 San Fernando Bldg., Los Angeles, Cal.; 324 Rialto Bldg., San Francisco, Cal.; and 342 Sherlock Bldg., Portland, Ore.

**New Standard Hardware Works, Inc.,** Mount Joy, Pa., manufacturers of the New Standard unit system and process for the hot-tinning and retinning of all kinds of metals, has obtained a contract for a No. 2 unit, which will be installed in the cream separator department of the Massey-Harris Co. Works, Toronto, Canada, for the purpose of hot-tinning steel stampings for cream separators.

**Fulflo Pump Co.,** Blanchester, Ohio, has found it necessary, owing to the increased demand for "Fulflo" pumps in the Chicago district, to establish an office in Chicago. The office is located at 6253 Ellis Ave. and is in charge of R. E. Manly of the Manly Sales Co. A stock of pumps will be maintained at Chicago, including all the standard pumps for machine tools, grinding machines, circulating baths, etc.

**Cleveland Milling Machine Co.,** Cleveland, Ohio, manufacturer of milling machines, milling cutters, and special tools, has recently completed a three-story addition to its plant. The new building is of the most modern construction, and includes all the latest sanitary appointments for the employes, such as shower-baths, and a dining-room, that is considered to be one of the most up-to-date in any shop in the vicinity.

**Tacony Steel Co.,** Tacony, Philadelphia, Pa., has opened a district sales office at 2 Rector St., New York City, with Paul J. Driscoll, New York district manager of sales, in charge. W. W. Corkran, formerly with the Midvale Steel Co., is assistant manager of sales in the New York district. The company has also opened a Cleveland office in the Swetland Building under the direction of W. W. Keefer, as district sales manager.

**Barrett-Cravens Co.,** 171 N. Anne St., Chicago, Ill., builder of Barrett lift-trucks, has moved into a new three-story factory building at 169-173 N. Ann St., Chicago, Ill., where the company will combine its shop, office, and warehouse in one location. The sales office was formerly located in the Transportation Building, Chicago, but will henceforth be at the new address. The new shop will give a considerable increase in the manufacturing space and facilities of the company.

**O. R. Adams Mfg. Co., Inc.,** Rochester, N. Y., has just increased its capital stock from $30,000 to $150,000, and has let a contract for a new building to take care of the growing demand for the Adams "Short-cut" lathe. The new building will provide about 4500 square feet of floor space. F. H. Brown, formerly sales manager of the Sherritt & Stoer Co., has been elected president and general manager, and O. R. Adams, secretary and treasurer.

**Collins Rotary Safety Razor Sales Co.,** 519 First National Bank Bldg., Chicago, Ill., has under construction a new factory located at West Lake St., between 43rd and 44th Aves., Chicago, Ill., which it expects to occupy in July, and where it will manufacture the Collins rotary safety razor. The size of the building is 158 by 200 feet, two stories high, built of brick, concrete, and steel. The company is now tooling up and equipping for a first year's production of 400,000 razors. H. A. Hassalquist will be superintendent and production engineer of the new plant.

**Fellows Gear Shaper Co.,** Springfield, Vt., has found it necessary to make further extensions to its plant, which was considerably enlarged during 1918, owing to its rapidly increasing business. The additions will consist of a 144- by 147-foot shop of steel and brick construction, two stories high, and a new office of steel and brick construction, 42 by 102 feet. The new shop will increase the manufacturing capacity of the plant about 60 per cent. The company now employs approximately 450 men, and when the new plant is in operation the force will be increased to approximately 750. The contract for the extension has been let to the New England Structural Co. of Boston.

**National Foundry & Machine Co., Inc.,** is a new corporation that has taken over the business and property of the Michigan Tool & Machine Co., Ypsilanti, Mich. The new concern will manufacture, on a large scale, the well-known Michigan power presses, which have been on the market for nearly thirty years, and the Michigan multiple drilling machines, and will also make gray iron castings from one pound or less up to 30,000 pounds. The officers are as follows: President, Robert E. Vincent; vice-president, William Downey; secretary, Winthrop D. Allen; treasurer, Ira S. Parke; and assistant treasurer and general manager, William Nickless. The company has plants at Ypsilanti and at Plymouth, Mich.

**Solar Metal Products Co., Inc.,** Columbus, Ohio, announces the following changes in its organization: G. R. Le Sauvage, who was elected president in January, 1919, has been released from active duty in the United States Naval Reserve Force, and has assumed the duties of general manager of the company, succeeding H. R. Gogay, formerly vice-president, treasurer, and general manager. E. C. Camp has been elected assistant treasurer and assistant to the president, and will continue his work as sales manager in charge of sales and advertising. A. C. Rollins has been elected treasurer, and E. C. Probst has been appointed purchasing agent and chief of the order and service departments. A. Miller has been appointed works manager, and H. C. Miller has been made superintendent of the paint enameling department.

**Black & Decker Mfg. Co.,** 140 S. Calvert St., Baltimore, Md., has established a New York office at Room 2020, Equitable Building, which will be in charge of G. R. Lundane, who will supervise the distribution of Black & Decker products in New York City and the surrounding territory, including the state of Connecticut. Mr. Lundane was formerly connected with the Thomas B. Jeffery Co., Kenosha, Wis., in the capacity of service manager of the Kansas City plant. He subsequently handled the Jeffery car for the state of Illinois, and has recently been connected with the Findeisen & Kropf Mfg. Co., of Chicago, Ill., manufacturer of the Rayfield carburetor, as the Eastern District sales manager. The Black & Decker Mfg. Co. now has branches in New York, Philadelphia, Atlanta, San Francisco, Chicago, Detroit, Columbus, Buffalo, and Boston. The company also has foreign connections in England, France, Norway, Sweden, and Japan.

**Clark Equipment Co.,** successor to Celfor Tool Co. and the Buchanan Electric Steel Co., Buchanan, Mich., announces that all employes of the company, whether paid by the month, day, or hour, who have been employed by the company for one year or more will be allowed one week's vacation with full pay. The new plan goes into effect this month, and includes all machinists, toolmakers, molders, etc., irrespective of employment. Heretofore, as in other corporations, this privilege has been granted only to the officers and to the office and clerical forces. The company has just completed a hospital for the use of its employes. While this hospital is intended primarily for the employes of the company, it is open to local residents at cost. The hospital is known as the Clark Hospital, and is provided with modern equipment throughout. It is situated in proximity to the company's plant so that emergency accident cases can be cared for promptly. The operation of the hospital is directed by the Clark Hospital Association, an organization of employes of the Clark Equipment Co., and of residents of the community.

**Allied Machinery Co., of America,** 51 Chambers St., New York City, has increased its capital stock to $5,000,000. This was made necessary by the decision of the American International Corporation to group all of its machinery export selling subsidiaries under one head. This move contemplates the complete absorption of the Allied Construction Machinery Corporation by the Allied Machinery Co. of America. The Allied Machinery Co. de France and the Allied Machinery Co. d'Italia will retain their corporate entities, but their parent corporation will be the Allied Machinery Co. of America rather than the American International Corporation as before. This is also true of the Horne Co., Ltd., of Japan, which was purchased early in the year by the American International Corporation. J. W. Hook will continue as president of the Allied Machinery Co. of America, in general charge of the business. F. A. Monroe, S. T. Henry, and T. G. Nee have been elected vice-presidents. Mr. Monroe is in charge of the administrative affairs of the company. Mr. Henry is in charge of sales and advertising and Mr. Nee is at present in Japan devoting his attention to the affairs of the Horne Co., Ltd. R. P. Redier is general sales manager of the company, with headquarters at Paris.